shortened for publication
Kenneth Warheit's work
to come

OSO note
remind

PELECANIFORMES

Family Sulidae -- Boobies and Gannets

Genus Morus Viellot

Morus sp.

Referred material. From locality 4546, associated right and left humeri, ulnae and badly crushed radius, LACM 120433.

Discussion. These wing bones are assigned to the genus Morus rather than to Sula on the basis of the relative length of the humerus to the ulna --humerus longer than ulna. The humerus is larger than humerus LACM 7432 from Sharktooth Hill previously referred (Howard, 1966) to Morus vagabundus: length of humerus LACM 120433, 185 mm; lenth of humerus LACM 7432 170 mm

Discussion. This material will be included in Kenneth Warheit's study of the family Sulidae now underway at the Univer sityof Califoria, Berkeley. In my brief examination of th specimens from both Oso Dam and Sharktooth Hill, I noted that two humeri in which measurements could bd compared with those from Sharktooth Hill exceeded those ascribed to Morus vagabundus, the only species recorded from the Kern County locality. LACMa 120431, distal end, breadth 21.0, holotype M. vagabundus 18.3; LACM 120433, length 183, referred M. vagabundus (Howard 1966) 170 mm. However, measurements made on a series of 12 distal ends of humeri from Sharktooth Hill showed a range in size from 15.8 to 21.8. ~~The tarsometatarsus LACM 120432 from Oso Dam thoughincomplete, provided a measurement of length comparable to that of a referred specimen of Sula willetti~~

~~Careful examination~~ to find that structural characters may reveal more than ~~as~~ possible from ~~my~~ alone

ORDER PELECANIFORMES

Family Sulidae -- Boobies and Gannets

Sulidae sps.

Referred Material. From locality 4546: associated right and left humeri, ulnae and badly crushed radius, LACM 120433; associated left coracoid and proximal fragment of shaft of left humerus, LACM 120428; ~~associated left coracoid and proximal fragment of shaft of left humerus LACM 120428~~; right tarsometatarsus lacking part of proximal ~~efn~~ end, LACM 120432; proximal end of radius, LACM 120429; proximal end of humerus, LACM 120430; distal end of humerus, LACM 120431: skull fragment, LACM 120427.

From locality LACM 4547: associated incomplete radius and ulna, LACM 120438; humerus LACM 123910; associated seven incomplete and poorly preserved bones lying together in matrix with the following elements represented: incomplete mandible, proximal end of right humerus, 3 fragments of left humerus (aproximate length 177 mm) distal end of right radius, fragment of left ulna, proximal end of left radius overlying left carpometacarpus (length ~~121.~~8mm), LACM

Discussion. This material will be included in Kenneth Warheit's study of the family Sulidae now umderway at the University of California.

Based on size alone, the specimens appear to represent at least two species, one of which is, LACM 120433. The humerus of LACM 120433 measures 183 mm in length, as contrasted with humerus LACM 7432 from ~~Sharktooth Hill~~ from Sharktooth Hill referred to to Morus vagabundus (Howard, 1966), with a length of 170 mm.

ORDER PELECANIFORMES

Family Sulidae -- Boobies and Gannets

Sulidae sps.

Referred Material. From locality 4546: associated right and left humeri, ulnae and badly crushed radius, LACM 120433; associated left coracoid and proximal fragment of shaft of left humerus, LACM 120428; right tarsometatarsus lacking part of proximal end, LACM 120432; proximal end of radius, LACM 120429; proximal end of humerus, LACM 120430; distal end of humerus, LACM 120431; skull fragment, LACM 120427.

From locality LACM 4547: associated incomplete radius and ulna, LACM 120438; humerus LACM 123910; associated seven incomplete and poorly preserved bones lying totether in matrix with the following elements represented: incomplete mandile, proximal end of right humerus, 3 fragments of left humerus, distal end of left radius overlying left carpometacarpus, LACM

Discussion. This material will beincluded in Kenneth Warheit's study of the family Sulidae . In my brief examination of the specimens from both Oso Dam and Sharktooth Hill, I noted that two humeri from Oso Dam exceeded in measurements specimens of Morus vagabundus, the only species of Sulid recorded from the Kern County locality: LACM 120433, length 183 mm (referred humerus of M. vagabundus Howard, 1966, 170 mm.), and LACM 120431, distal endbreadth 21.0 mm, holotype of M. vagabundus 18.3. However, measurementsmadeon a series of 12 distal ends of humeri from Sharktooth Hill showed a range in size from 15.8 to 21.8 mm. We await with interest Mr. Warheit's analysis of structural characters involved.

The other extreme in size is noted in the associated bones of LACM 120428. Although the humerus cannot be measured, the coracoid and tarsometatarsus agree in size with those of a referred specimen of Sula willetti, UCLA no. 2839/(Miller 1925, pl. 8), but not discussed. This specimen was available for the present study. Both the coracoid and tarsometatarsus from Oso Dam are in close agreement with impressions of these elements in the UCLA specimen.

Sula willetti has not been recorded from Orange County LACM locality 1945 or from Sharktooth Hill. However, several small bones were noted from locality LACM 1945 (Howard, 1968) as being comparable in cerain characters with Microsula avita Wetmore 1938, which appears to have been similar in size to Sula willetti. In the Sharktooth Hill material, LACM 98601, consisting of associated humerus, ulna and coracoid, is also of small size (humerus length 155.9 mm, distal breadth 16.5 mm). The humerus in the holotype of S. willetti is listed at 156 mm (Miller, 1925, 114). It should be noted, however, that both humerus and ulna of LACM 98601 show characteristics resembling Morus rather than Sula (distal end of humerus with medial border of olecranon fossa not overhanging the fossa, and ulna lacking multiple pneumatic openings below cotylae. These areas are not clearly delineated in the impressions that form the holotypes of the Lompoc material.

The seven associated elements (LACM) possibly represent Morus vagabundus, the only sulid reported from Sharktooth Hill. The carpometacarpus measures approximately 72.8 mm, the humerus 177 mm.

ORDER PELECANIFORMES

Family Sulidae -- Boobies and Gannets

Referred material. From locality 4546, associated left coracoid and proximal fragment of shaft of left humerus, LACM 120428; right tarsometatarsus lacking part of proximal end, LACM 120432; associated right and left humeri, ulnae and badly crushed radius, LACM 120433; proximal end of radius, LACM 120429; proximal end of humerus, LACM 120430, distal end of humerus, LACM 120431; skull fragment, LACM 120427. From locality 4547: associated incomplete radius and ulna, LACM 120438; humerus LACM 123910; associated seven incomplete and poorly preserved bones lying together in matrix, with the following elements represented: proximal end of right humerus, distal end of right radius, three fragments of left humerus, fragment of left ulna, proximal end of left radius overlying left carpometacarpus, uncatalogued.

This material will be included in Kenneth Warheit's detailed study of the family Sulidae now underway at the University of California.

Based on size alone, the specimens appear to represent at least two species, one of which is obviously too large to conform with the description of Morus vagabundus Wetmore 1930 (holotype distal end of humerus, breadth 18.3 mm), the only sulid described from Sharktooth Hill. The humerus of LACM 120433 measures approximately 183 mm in length, as contrasted with humerus LACM 7432 from Sharktooth Hill previously referred (Howard, 1966) to M. vagabundus, with a length of 170 mm and distal breadth of 18.4 mm. That the genus Morus is represented, rather than Sula is suggested by the length of the associated ulna which is of lesser length (158.6 mm) than the humerus.

Galidae

Dec. 5, 1985

128.7 126.75 160
48.3 51.4 17.1
177.4 178.1 177.1

Anous 1773 with 69 casques
730 cachn " "
arg 1 1881
4547 Sulid layers
carpenta. 1133

.44.8
brits 166.7)7590
lens 6688
8220
6685
1535
1513
22
.413
Oso 1774)7330
7096
2340
1774
566
322
.394
Anous 2215)8740
8643
2095
1935
1015
886
129

.44.5
s dent. 1955)8700
7820
8800
7820
980

41
177.4)7280
7096
1840
1774
66

.44.8
S. piscator 168.5)7570
6760
8100
6765
13400
11795
1605

.42.3
S. e brewsteri 1710)7240
6840
4000
3420
580

Rosche 5'5'5'
Radius of Oso specimen has angular shaft ~~cross s, dactylate~~ clear from dist end
as in Sula / (Anous is widely rounded (almost flat
particular dactylate. But Oso lacks the
pneumatic of dactylate + Anous Sula + in this
is more like Anous
On Oso wade it blends down of both
absence of pneumatic = Anous
more angular shaft = Sula

Sulidae genus and sp.?

Referred material. U ncatalogued material from locality 4547. Associated distal end of radius, proximal end of (opposite?) radius, proximal end of right humerus, 3 fragments of left humerus (estimated length 165.5 mm) with incomplete eroded distal end, lefct carpometa carpus (length 72.8 mm, depth distal end 12.8 mm), distal half of (left?) ulna

Referred material. From locality 4547 (uncatalogued): seven incomplete bones lying together in matrix, with the following elements represented: proximal end of right humerus, 3 fragments of left humerus with ~~incomplete~~ eroded distal end (length possibly 165.5 mm), distal half of ulna, proximal end of radius overlying a left carpometacarpus (length of carpometacarpus 72.8 mm, depth distal end 12.8 mm), separate distal end of radius, anteiro end of lower mandible in 3 pieces. Collected August 9, 1981.

From locality 4546, skull fragment no. 120427, ~~proximal end of~~ two humeri nos. 12030 (proximal) and 12031 (distal), proximal end of radius 120429.

1352 new # 86439 ♀
1356 " " 86436 ♀ ♂
253 " " 86432 ♂
1334 " " 86434 ♀ breeding

S. sula websteri nearest rel. to OSO — Dec 5, 1988

Measurements of Sulidae (mostly fr cf with 1981 plaque)

from OSO Anclote 454 ♀ RRanch 555

OSO Don 177.4 dist 20.3 int — 92.8 ♂ 73. Gr. dist radius 11.5

	Carpal	Humerus	ulna	carpo.	Tibia	femur	tarsus
1352 S. leucogaster	52.2 int / 57.2	166.7	168.5 int / 177.8	77.9 int / 79.7 ext	82.4	35.3 ext	51.5
1356 S. dactylatra	54.8 int / 64.7	195.5 dist 20.2	202 int / 209 ext	89 ext / 87 int	94.8 (11.5 Gr dist radius)	63 ext	62.4
253 S. nebouxii	50.4 int / 54.2	168.5	173.2 int / 183.2 ext	77.3 ext / 75.7 int	86.6	53.9 ext	51.2
1336 S. sula websteri	51.7 int / 56.5	171.0 dist 21.0	181. int / 189.5	74. ext / 72.4 int	71.5 (20 dist radius)	51.6 ext	46.0
Nannopterum harrisi	68.8 int / 71.3	221.5 dist 23.9 dist 21.0	183.4 int / 191.3	93.0 ext / 87.4 int	98.5 Gr. dist radius 12.6	69.7 ext	56.7

Measurements

Breadth of humerus as in S. sula websteri but humerus longer, carpus slightly shorter but tarsus longer. Superficially ♀ S. s. websteri with light feet?

Plaque OSO	Humerus	(177.4)	dist. 19.5 ?? 20.3 ?	carpus 72.8 ?	dist radius 11.5	
Ranche 555	dactylatra	195.5	20.6	" 87.0	" " 11.5	
	leucogaster	166.7	20.4	" 75.9	" " 9.9	
	Nannopterum	221.5	23.9	" 87.4	" " 12.6	
	Shaublatt #98601	(155.9)	16.8 (prox 21.8)	depth dist 9.5 ?		
	Other: 6-C-9		20.7	= ? 122970 now?		
	6-C-8		prox 28.8			
	6-C-10		21.0			
				80.0		
	Type rag.		18.3	depth dist 11.2		
	#13980 Isa 16 25 14 1966		17.2			
	(1961 Mallo) Nannopterum 30 Galapagos					
	New rag.					
	rag tube		18.3			
	Shaublatt # 38801		21.3			
	17496	163.4	17.4			
	30618		20.4	30619?		
	uncat. 914		19.6			
	#1660		20.4			
	122970		20.5			
	122997		21.8			
	72817		16.2	min.	modern sula I. Bunch min. 16.7	
	122997		21.8	max	max 19.5	

Data on Sulidae from various notes

OSU
for
4546 Lacm 120433 br dist 21.0 (Br. dist M. luxitylo @ Walvis = 21.1
also small crozet, turn wing white 120428 tarsus length 44.6 mb. valenti also 44 type mid-Atlantic specs (18.3, 18.5)

Shag tarsometatarsus + dist
4954 humeri
6-C-10

dist. Sq 6-D br dist 15.8

dist 2-D-23 br dist 18.5

OSU Lacm 4546
humerus
120433 length 182.3 [ulna assoc. length 159.1 + prox 14.2]
or mm (1043)

for 6688 Shag tarsometatarsus
17496 length 163.~~0~~ see below same one)

humerus
7432 length 170 (Howard ref) dist br. 18.45

51660 dist br. 20.5

ler 16.5

17496

ler. 6688 163, dist br. 17.4 (see above same one)

Muscular cavity humerus dist br 15.2

Shag tarsometatarsus
humeri

vary in dist brs. from 16.2 (# 72817) to 21.8 (# 122997)
15.8

15.8 # 6-D
16.2 # 72817
17.4 length 163.4 # 17496
18.3 type var.
18.45 # 7432 length 170
19.6 # 50618
20.4 # 50660
20.5 # 122970
21.3 # 38809
21.8 # 122997

length 155.9 155.9 br 16.2
170 br 18.45
163.4 br 17.4

wallist tarsus 156

18.9
20.8.3

15.8 – 21.8 shag tarsometatarsus dist
~~155.9 – 170~~ length
155.9 – 170 ~~length~~

OSU 120433 Humerus

182.3 OSU
~~15.0~~ – 21.0

Sula leucogaster Crozet humeri
length 147.5 – 166.2
dist br 16.7 19.5

166.2 21.8
147.5 15.8
18.7 6.

OSU humeri from 182 to -?
Shag 170 + to 155.9

Jan 1986

Locality LACM 4546 p. 4a See back page (1A

Family Sulidae (Boobies and Gannets) Loc 4546
LACM 120428 collected May 7, 1980
Sula ? willetti Miller (Holotype Lompoc diatomite)

Coracoid fits the impression of this element in UCLA specimen 2839 referred to Sula willetti by Loye Miller (1925, pl. 8) and more slender than any Sulid coracoids from Shaktoolik Hill.

fragment of proximal portion of shaft of humerus and proximal end (fragmented from the shaft). More slender than Sulid humeri collected from Loc 4546 on April 18, 1976 (LACM # 120433)

See Loc 1945 humerus LACM 17554 assigned to Micranous see Miller Edwards also on M. pygmaeus 1854 humeri

LACM no. 120432
Sula ? willetti Tarsometatarsus lacking part of proximal end.

See Loc 1945 tarsus LACM 17554 assigned questionably to Micranous

Length (est.) 44.6 mm. (Length in type of Sula willetti 41.0 mm; length in referred specimen from Lompoc - UCLA 2839 - 44.6) (Miller 1925, pl. 8)
Distal breadth 12.2 mm (UCLA 2839, 11.5 ?)
Breadth of shaft 6.0 mm (approx. 6.0 in cast of type of S. willetti)

Very small Sulid
Length 24.5 mm

middle trochlea longest, internal trochlea next longest; external trochlea slightly higher than internal. (Relative lengths of trochleae appear to be same in UCLA 2839
See yellow lined tablet for detail comparison with modern species of genera.
#120432 resembles S. willetti tarsometatarsus in more slender shaft than in modern species of genus Sula and the distal flare more balanced.

79.3 : x = 40 : 100
40x = 7930
x = 19

OVER
Loc 4547

Loc. 45'47

Sula ?, willetti continued.

Radius LACM 120438 Loc 45'47 cont'd

Narrow shaft with abruptly flared distal end – more like Sula than Morus. No radius in the Lompoc diatomite Sula willetti shows details of radius

Ulna LACM 120438 (distal end, ext. side only)

Depth of external trochlea 8.4 mm, and shaft apparently slender (though crushed) 4.6 x 5.7

Larger ulna from loc 45'46 (probably Morus) measures 9.6 in distal depth and shaft is heavier (8.5 x 6.7)

---

4 here Total fossils referred (?) to Sula willetti

Loc 45'46 coracoid and humerus # 120428

tarsometatarsus # 120432

Loc 45'47 distal ends of ulna and radius # 120438

Breadth of ulnae referred to Morus vagabundus Loc 1625 Shaft bot/L.H.I. br/depth shaft 6.6/5.8

# 16473	br. prox end	13.5	depth internally	12.0
16470		12.1		
? 38800		11.2		10.6
? 17607		12.0		

6.25/6.9

5.8/6.6

---

4 Pair here

Pelecaniformes

Sulidae - Boobies and Gannets

Loc 4546 1. Sula ? willetti Miller

A, Associated coracoid and proximal fragment of humerus LACM # 120428

2 of 1

The coracoid fits the impression of this element in UCLA specimen 2839 from Lompoc (at hand) referred to S. willetti by Miller (1925 fol. 8) It is more slender than any sulid coracoids in the Shaktoolik Hill collection.

Humerus is much more slender than humerus LACM 120433 collected from Loc 4546

.1 B. tarsometatarus LACM 120432 lacking part of proximal end. Estimated length 44.6 mm. ~~The length of this element in the type of S. willetti from Lompoc is 41.0 mm.~~

The length of the tarsometatarus in UCLA 2839 (see above) is also 44.6 mm. In the Robertyle specimen however the length is 41.0 mm.

Loc 4547 . Sula ? willetti from Loc. 4547

2 of 1

Associated manella radius and ulna LACM 120438

Cannot be compared with Lompoc material, But small size suggests same species as in 4546. The shape of the radius is more like Sula than Morus.

Loc. 4546 Morus sp LACM 120433

5 of 1

Associated humeri, ulna, radius (5 bones) badly crushed referable to genus Morus on basis of humerus longer than ulna. Larger than specimens from Shaktoolik Hill referred to Morus vagabundus not only in length but in shaft breadth. Humerus, more study of Shaktoolik Hill material is desirable.

Humerus much longer than 120428 (bones)

14 bones this page

Identifications of bird Bones from Upper Oso Dam

Note: Crushing of some specimens makes definite identification impossible

Procellarii formes

Family Diomedeidae – Albatross

4547 Diomedea sp. ♯ 120439 loc LACM 4547
Asp. Proximal end of ulna ~~(right)~~ and distal end and shaft fragments of radius

Possibly D. milleri though slightly larger

[Two sp. of Diomedea described from Shaketooth Hill: D. californicus (large) ♀
D. milleri (small) Br. prox. end 15.8 (D. nigripes 17.6 D. nicobarica 14.4)

Family Procellaridae – Shearwaters all Loc 4546

4546 of Puffinus priscus Miller all from loc 4546
Nearly complete humerus ♯ LACM 120415 (L & R)
Two humeri and ulnae (rt) ♯ 120416 dist br. 7.8 (P. priscus 7.3) S.H. [8.3
humeral length (Rt 81.2 [P. priscus 81.6)
Distal end of right humerus ♯ 120417
Ties in with type (dist. end) and completely referred specimens of P. priscus from Shaketooth Hill (type locality of P. priscus)

4546 ~~Puffinus sp. (except for Holotype)~~ (holotype a distal end from Shaketooth Hill)
Right humerus complete (but crushed) 120422 =
and associated proximal end of ulna (very crushed)
and proximal & distal ends of radius
? Note: Humerus resembles complete humerus from Shaketooth Hill (Arndt DI4) referred to P. creatopus but longer 120418.

4546 Puffinus sp. Right carpometacarpus 120419.
shaft br 2.7 dist br 6.3 large and stocky
Same conforms in size Sh. Hill ♯ 104058 Loc. 1623 Right humerus 120423. and 120424.
prox. & dist. frags. radius
prox. frag. ulna (left) 120425. and 120426.
2 dist. ends tibiotarsi 120420.
Complete right ulna 120421.
transmit to right ulna

Loc 4546 ↓ 120412

ORDER PELECANIFORMES

FAMILY Sulidae

Genus Sula -- Boobies

Sula ?willetti Miller 1925

Referred Material. From LACM locality 4546, associated coracoid and proximal fragment of shaft of humerus, LACM no. 120428, collected by May, 1977, 80; tarsometatarsus no. LACM 120432 lacking part of proximal end. Collected by . From locality LACM 4547: associated incomplete radius and ulna, LACM 120438. Collected by .

Discussion. The coracoid of no. 120428 fits the impression of this element in UCLA specimen no. 2839 from the typelocality of Sula willetti referred (Miller 1925, pl. 8) to S. willetti. It is more slender than any sulid coracoid in the Sharktooth Hill collection. Estimated length of tarsometatarsus 120432 is 44.6 mm. The length of this element in UCLA specimen 2839 (see above) is 44.6 mm. In the holotype associated skeleton of S. willetti (UCLA UCMP no. 26542) the tarsometatarsus is 41.0 mm.

The associated radius and ulna from LACM locality 4547 cannot be compared with the Lompoc material. The small size of these incomplete specimens, however suggests the same spcies as represented in locality 4546. The shape of the radius resembles that of Sula rather than Morus.

Genus Morus -- Gannets

Morus. sp.

Referrrd Material. From locality LACM 4546: Associated humeri, right and left ulnae, radius badly crushed. LACM no. 120433 (5 bones)

Discussion. The wing bones are assigned to the genus Morus on the basis of the relative length of the humerus to ulna--humerus longer than ulna. The bones are larger than wing bones from Shrktooth Hill referred to Morus vagabundus, both in length and in breadth of shaft. The humerus is also notably larger than LACM 120428 from the same locality, referred to Sula ?willetti.

Measurements: humerus 185.6 mm, ulna 158.6 mm.; length of humerus 7432 from Sharktooth Hill 170 mm (Howard, 1966:6 and fig. 1,J)

The ulna also is larger than any ulna in the Sharktooth Hill collection: breadth of proximal end 14.1. Three Sharkrooth Hill ulnae measure 11.2-13.6 mm in this dimension

Subdas

→ to walkaround → frag of large dist radius + shaft area HERE

5(1) 120433 assoc (?) wrg form lvc 45446

2/1 120428 left humerus + left ulna prox+shaft

1(1) 120427 skull 45445

1/1 120431 — humerus 120437

walkaround 1/1 120432 S. 2 midshaft in contact w/ femur 45446

1/1 120430 humerus lvc 45446

2/1 120438 assoc radius+ulna 45446

1/1 123910 humerus lvc 45447

1/1 120429 prox radius (IS HERE)

7/1 uncatalogued in plaster (new)

Measurements of S. lavocqauba brasiliensis

	86439 (old # 1352) (4, 5, 8)	86438 (old # 1349)	84437 (251)
Humerus	166.2	147.3	163
dist	19.4	16.6 (14.8 quarry # damaged)	18.4
prox	23.8 gr	20.3 (20.2)	23.5 gr
ulna			
prox	13.1	11.1	12.6
dist	12.5	10.3	11.2
Carpometacarpus			
ext length	77.3	70.3	78.9
int "	75.3	68.6	77.3
Coracoid			
vit length	52.2	47.7	53.6
gr br.	14.3	11.5	13.6
Tarsus			
gr length	51.1	46.0	56.5
prox br. (Incisio ondus)	13.7	11.6	13.5
dist br.	14.6	12.0	14.0

humerus 166.2 19.4 23.8
147.3 16.6 20.3
18.9 2.8 3.5

carpo. 77.3
70.3
7.0

coracoid 52.2 53.6
47.7 47.7
4.5 5.9

14.3 13.6
11.5 11.5
2.8 2.1

ulna 13.1 12.5
11.1 10.3
2.0 2.2

tarso, 51.1 13.7
46.0 11.6
5.1 2.1

Max & min. Shaft both

086

Humerus
length (same bone 16.8 dist) 155.9 – 170 (dist 18.45 ?)
br dist 16.2 (no length) 21.8 (no length)

same bone { 177.4 – 184 → not same bone
19.5 – 21.0

Ulna
9860 1 = 11.7
prox 11.3 – 12.0 no length

Carpometacarpus
length 68.1 – 80.0
(77.6 – 79.3 between)

length 72.8 or 73.0

Cracid
length (same bone 52.2 – 57.8
gr. br (not same bone 13.7 – 15.7
least 13.0
9860 1 48.2 + 5' = 48.2 ?

Sulidae continued

4544 Sulidae genus + sp.? from 4544 but

Skull fragment 120427

Prox end of radius 120429

prox end of humerus 120430

dist end of humerus 120431

Order Charadriiformes — Shorebirds

Family Alcidae

Subfamily Fraticulinae

? Alcodes alnulus Howard (holotype from Los Coronados, 1945)

(6) See next page 3 bones fragmentary

120414 humerus

120434 ulna

~~1220~~ 121010 coracoid

Auas sp.

4545 ~~H 120433 skull frag. loc 4545~~ not Auas

~~H 120435 crushed humerus loc 4546~~ ?

4546 H 120436 dist end femur loc. 4546

H 120437 crushed ? humerus loc. 4546

9 to be combined
~~X~~ bones this page

	bones
4464 —	1 OK
4545 —	1 bone of Alcodes
4546 —	~~2~~ 3 3
4547 —	~~3~~ 5
loc ?, —	5

Locality 4546 – Upper Oso Dam Mission Viejo

Sulidae – LACM specimen # 120433 Rt & left humeri, Rt left ulnae (museum frags)
LGB loc. 1926 April 15, 1979
R & L inc humeri – joined together L left has prox & dist end
R has prox & dist & shaft

L measured 184 mm (Limpocarpus measure 229–280)
Morcular 180–190?

The joined together humeri of # 7432 from Shark Tooth Hill measured "at least 170 mm"
("exceeds S. pohli" by 20")

	Shark Tooth Hill M. vagabundus	# 120431
dist br. type	18.3	21.0
br. condyles	14.3	?
ht. at "	16.3	?

The humerus agrees with prox of # 7432 (Sh Tooth Hill) Loc 1625
& prox # 38601 " " " Loc 1425
in having distinct angular rise of prox end of shaft
starting at about the level of the distal edge of
The pneumatic fossa, but with the internal
surface immediately below the head flat (as in morus)
The angular rise, however, is not found in
morus but is more exaggerated form occurs in
Sula (at least S. bassanus).
The distal end of the left humerus from 4546
has a much larger external trochlea than
in the specimens from Sh Tooth Hill. As
the 4546 bone has been repaired this may
be due to repair.

Loc 4546
br. dist 15.2 mm
less deep olecranal fossa than S. piscator

@ Wetlands, 930 M. vag. Defs of morus from Sula in dist end humeri

Operculator attach low, narrow & nearly plane & olecranal depression lacks pronounced overhang on inner side where there are a few foramina [in Sula the processor attach is shorter & much rounded & there is a very evident overhang on the inner side with large evident foramina at this point

head to end of del tuberosity 44.4 from 4546 (Bonita 1926 ← LACM 120433 (Bonita 31.5?)
repaired → LACM 120430 → 39.3 " 4546 (Bonita 31.5?)
39.6 # 38601 from S T Hill Loc 1625
41.4 # 7432 " " " " "

Difficult to compare br. prox end & dist ends due to crushing
Sh in 120433 humerus 8.2 × 10 Loc 4546
" " 7432 7.7 × 9.8 Sh. Tooth Hill Loc 1625

Ulna

44.7 = length tarsus from 4546
12.1 br. dist end " " "

Br. hum dist # 120431

Ulna Bauer 1924 from 4546 Oso Dam LACM 120433
Prox br 14.2 length 159
ulnar for Sh. tooth (tibia br. Prox LACM 13.4, 12.0) LACM 17607
Again the 4546 specimen is crushed
Does crushing account for the marked depression on lateral side (brachial impression)
Size slightly larger than ulna of ST Hill

Mioziala media humerus 180-190 late mold 179.7
ulna 179-140 140.7

Nomus lompocus humerus 239-245
ulna 202

Oso Dam humerus 184
ulna 159

Palaeosula Stahlmi humerus 242? or 244?
ulna 175

Suba wellsi humerus 156 (152) 151.9 / 145 / reverse of type
ulna 147 146)

Suba pohli humerus 150
ulnae 170

Nomus vagabundus humerus 164? (170?) br 18.5 or 18.3
ulnae ?

Locality 4546

Saliidae
LACM 120433
Morus — try vagabundus but seems to be
larger than specimens from Shaktoolik Hill
Two humeri 185.6 length on one
Ulna 158.6 " and fragments of another
Radius distal end breadth 10.3
Ulna breadth proximal end 14.15
external depth " " 14.6
internal depth " " 11.3
depth distal end ext. 9.45
breadth/depth shaft mid.) 6.7/8.7
" (above dist. end 6.2/7.8

Humerus - length pectoral crest 44.8 to head
Breadth/depth shaft (middle) 8.5/8.6

Check This specimen again for length 163.? yes

Length of humerus 17496 from Shaktoolik Hill is 163.1 mm (at least 19 mm)?
Shorter than 120433 from 4546

Length humerus 7432 from Shaktoolik Hill (2 pers together, smith 1966) is 170mm.

OK

185.6
170.0
15.6

185.6
163.1
22.5

Note:
Check with what is known of
morus magnus from late Miocene

Notes 20, 1982
Aug. 20, 1982

Shaintoo Hill call'd by Howell W. + Thomas 1979a

Loc. 3162 Not yet catalogued (as of Aug. 19, 1982) UNcatalogued

Loc 3162 See labs typed pars for cata 20

Sulidae

× ✓ Prox left small humerus (21.4 prox br.) [Sula dactylatra 26.4)

× ✓ R + left upper end coracoids 12.7–12.8 br. through lower part of (ant (= gr.)
(part of humerus shaft in box with Procellariidae coracoids)

× ✓ Left upper end coracoid gr. br. 13.7

× ✓ Right " " " " " 15.7

× ✓ Anterior end sternum small

× ✓ Prox end right femur small (prox. br. 11.6 + chem protected = least br.)
Gr. br. 13.2

~~Dist end right humerus~~

× ✓ Dist end right humerus gr. br 20.7 (equiv. to Sula dactylatra in size)

× ✓ Humerus shaft at lower part of deltoid + distal pneumo (about 2 inches of it)
(br. just below deltoid 15.0mm (11.0 in S. dactylatra)

× ✓ Prox end left tibiotarsus br. of prox surface 9.9 (same meas in dactylatra 10.6

× ✓ Sternal end small right coracoid

× ✓ Prox end radius

Procellariidae

× ✓ Prox end right humerus (prox br. 17.0) ✓ copied

× ✓ Prox frag tibiotarsus (left) (br. artic. surface 6.9) ✓ copied

× ✓ Prox right ulna (Br. prox 7.7, depth prox 9.1) ✓ copied

Identification?

× ✓ Call'd Subj 1980 incomplete tarsometatarsus try Presbychen or ~~Myctinodromus~~

Call'd Subj Jumble 3161 by thomas

Unreferred

> distal ½? humerus Try Presbychen

> sysacrum + part of pelvis small – try sulidae

× fragment of tarsometatarsus try Diomedea (shaft) ✓ copied

× large (dist) pedal phalanx (incomplete)

× proximal end of humerus (large)? Check Phils 9.15.82

Loc. 3162
new Howell Thomas
1982

Shanktooth Hill material collo 1982 Loc 4956 21 Uncatalogued as of May 1982

Suidae

- ✓ prox half left humerus 6-C-8 (gr. br. 28.8 mm)
- ✓ dist rt " 6-C-10 (gr br 21)
- ✓ frag ends ? 6-C-9 ?
- ✓ left cnaneus 6-C-5 (57.8 - length to mid tip. sheath-like)
- ✓ ✓ left carpometacarpus 6-C-6 (gr. length 80 mm)
- ✓ ✓ left femur 6-C-7 (ext length 63.9, mid length 62.4)
- ✓ ✓ left femur 6-C-4 (ext length 56.0, mid length 54.5 both edges eroded)
- ✓ ✓ rt. femur 6-C-3 (stuck in matrix incomp. but seems close in size & ? 6-C-7)
- ✓ ✓ prox frag humerus 6-C-23 — Suid? probably the ♂ of the ♀ humerus 6-C-8)
- ✓ ✓ vertebra 6-C-22
- ✓ ✓ frag of skull 6-C-21
- ✓ ✓ fragmentary ulna stuck in matrix Sq-9-G (distend clear)
- ✓ ✓ left carpometacarpus prox + dist fragments 3-D-27 layer
- ? ✓ ✓ rt. " possibly Suid but very weak (length 68.1) # LGB 3285

Procellariidae

- ✓ ✓ Puffinus mitchelli? left humerus lacks head 10-B-31
- ✓ ✓ Puffinus sp small wing prox 7-B-24 (br 15.1?) shaft (dist epo? in matrix?)
- ✓ ✓ P. mitchelli complete ulna Sq-4-H

Pesbychen

- ✓ ✓ complete tibiotarsus 3-E-21 (gr. length 151.5) br dist 18.5+)
- ✓ ✓ nearly complete rt. femur 3-H-17 (ext length 81.2 + ext) int incomplete prox br 20.5
- ✓ ✓ incomplete left femur 10-D-28

Unidentified

small humerus 7-B-24 - somewhat in matrix

small frag gabel 6-A

frag of ?. Sq-4-C

fibula 3-A

Osteodontornis: Sq 1-I Rod Raeble 1982

Prox? frag humerus in rt humerus 5-H-14

new 1982 Loc 4956

Uncatalogued Shaftoath Hill locality 4956

Solid humeri

Proximal and distal ends formed associated

(1) 6-C-8 Prox width 28.5 (possibly wider - slight erosion)
6-C-10 Dist width 20.5 (max) condyles only 14.9

(2) Distal fragment Sq-6-D
Dist. width 15.8 (max) condyles only 12.5?

(3) Distal end 2-D-23
Dist width 18.5 max; condyles only 14.8

[Note: Type of Mores vagabundus given as 18.3
Cast measures 18.5]

TO Do Thursday Nov. 19, 1981

lesser be 14.6 dist end 15.2 condyles 12.8 Check Burmeus jug bas + shaft 120428 from 45°46 dist end

Nas very to Loc 1945 Burmeus 175°56 assigned deep depression to Micrasula (by key M. avita dist 6, 15.2) for olecranon between says ant is closer to Sula than Morus of ulna especially- ming post part of wtr. condyle How does jug end of 120428 compare to Sula vs Morus? Check line of latissimus dorsi muscle does it run "above" the central axis of the bone?

Check tarsometatarsus 120432 to LACM 17554 from 1945 which is also said (HH 1968) to be closer to Sula than Morus in more prominent intercondyla tuberosity,

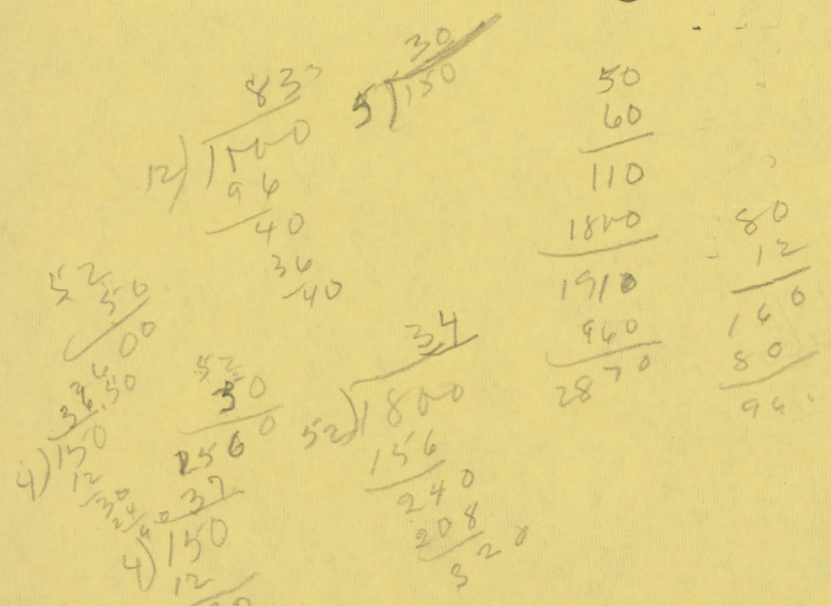
Check length of Micrasula avita carpo. to that of Sula willetti

Check Morus vagabundus ?? Burmeus 120431 dist end to M. vag. type size grade as 18.3 mm., radial condyle 9.5 high ulna " 7.2 "

#51660 from STHeil 16.2 same Check sh 12.9/7.5 51660 12.5/7.0

My later records show a downward trend from this size with min. 17.2

Length of vagabundus 7432 est as 170 mm in HH 1966 paper Check also length of #17496 shaft with Heil



Sulidae

Length of humerus 98601 from ~~Shaktoolik~~ locality 3499 — 154 mm
Small → breadth of distal end 16.4

Measurements of Sula willetti holotype from Miller 1925

length humerus 156
distal breadth ? ?

measurements of ~~Sula willetti referred~~
~~to Miller's specs.~~
Shaktoolik Hill 98601

length humerus 155.9
br. dist. n 16.8

Tarsometatarsus 120432 Oso loc. 4847
aprox length 44.6

Tarsometatarsus UCLA 2839 referred
to S. willetti (Miller 1925 pl. 8) 44.4

Tarsometatarsus holotype willetti 41.0

Carpometacarpus willetti (Miller 1925) 70.

Oso Dam uncat. Carpometacarpus 72.8

carpometacarpi

Oso uncatalogued Ranch — br. 45'47 — 72.8 ✓

Shaft tooth 123351 (la, 3162 — 77.6

Shaft tooth 123980 (la 4954 — 79.3

Sula multite Type Miller — ~~66.7~~ 70.0 ✓

humeri

Oso uncatalogued Ranch — br 45'47 — 172.4 ?

Or ? — 9.53-20

Shaft tooth 98601 — 155.9 ✓

~~69.2~~ 16.8

dist breadth 98601

Type Sula willetti — 156.0 ✓

~~reference S. willetti~~

UCLA 2839

~~Melamphidae~~ Mycteria

Type M. vaghundra br. — 185.3

Tarsometatarsi

Sula willetti holotype — 41.0

S. willetti referred

UCLA 2839 — 44.6

Oso 120432 — 44.6 approx

~~Shaft tooth~~ humeri

distal br ranges from 16.2 – 21.8 — (~~71.20 mm~~) 140 mm

modern S. b. leucogaster 16.8 – 19.5 — (~~86.0 mm~~) 116.02

Sharkbooth Hill – by family and element (3)

Salidae (39) Sulid?, carpometa unrecorded Oct. (cockt 26 1983)
br. trochlea 7.0, dept 13+ (MI broken) Lars Danielsen Loc?

Morus vagabundus + UCMP multiple recds 1961 T 1930 assoc with ulna

CAST of TYPE distal end of humerus in TYPE Case

in my drawer Loc. 1625 # 7432 humerus prox. + dist ends
in my drawer " # 13980 humerus distal end
1625 # 16467 humerus dist prox end
1625 # 16471 humerus proximal end
1625 # 38801 humerus proximal end
in my drawer " # 98661 complete humerus, + ulnae 2 prox.
in my drawer Loc. 3499 # 98661 complete humerus
in my drawer Loc 6688 # 19496 prox. humerus
" # ?
prox in my drawer 6688 # 50618 dist humerus
assoc. Loc 1622 # 104104 humerus - prox + dist ends (aerstc.)
" # 120951 humerus
Oct 19 Loc 4546 # 38808 ulna proximal end
in my drawer → Loc 1625 # 164702 ulna prox end
" # 164721 + two ulnae
Recorded → 1625 # 176073 ulna proximal end
Recorded → 1625 # 176073 ulna proximal end

Morus spp (suggests that there are + two spp of Morus)

Loc 1557 # 16468 + arsmetatarsus prox. end
in my drawer 1557 # 16464 + arsmetatarsus prox end
Loc 1625 # 17606 + arsmetatarsus dist end
humerus dist end
humerus in two parts

Sulidae spp. unrec.
Kirkland 9-14 # 7281 humerus shaft
Loc. 3162 # 98475 humerus dist br. 20.4
in my drawer → Loc. 3160 # 316001 humerus dist end
in my drawer → Loc. 1625 # ? ulna, right and left ulnae (Kirkland coll.)
Loc. 4173 # ?
Loc 3162 # 98475 ulna, distal end left
Carl fund 1982 Loc 3162 # 84792 and 98475 ulna shaft + part of dist.
Loc. 3162 # 98194 carpometacarpus prox. pt.
Loc 6688 # 17499 sternum (
Loc 5560 # 571701 coracoid, upper end pt
in spice Loc. 6688 # 50614 Distal end carpometacarpus
in my drawer 6688 # 17498 tibiotarsus proximal end pt
Loc 1455 # 37649 Coracoid Size = Webster's Length interval
Loc 1625 # 17507 from below juncture 50.4
in my drawer " 21042 ulna prox br. 11,2 dist " 11.4 " sh below head 6.3
Recorded → " 38800 ulna prox br. 13,6, depth 13,4 " " " 6.9
" 17607 " " " 12,0 " " " 6.8
Recorded → " 164702 " " " 11,9 " 12,0? " " 6.8

Sulidae
UCMP specimens collected by Mitchell (see Mullin 1961)
includes prox. frag of humerus Mullin assigns to M. vagabundus
size & Sula nebouxii
also a large ulna equal to or longer than tarsometatarsus
† Mullin remarks Morus not Sula.

Oct 20 Add 1622 / 120027 dist humerus Br 16.7? Rutherford

Recorded → 1625 # 164721 ulna proximal end
Recorded → 1625 # 164721 ulna proximal end
Recorded → 1625 # 164721 ulna proximal end

Additions from Skaketook this May 1982 Loc 4956

Loc 4956 + / # 6-C-9 Dist al end Humerus br. 20.7 or 20.8
[see # Loc 1625/21662 which is 20.4 br.) vagabundus type = 18.7 or 18.3.

together ? # 6-C-8 Prox end Humerus br 28.9

6-C-5 Coracoid length to internal tip of sternal end 57.4) (measured tip to tip 24.7 mm to articular tip 23.6)
br, glenoid facet 14.6
(Cf 21042 which measures 56.4)
Loc. 1625

6-C-3 ~~nautica~~ rt femur - length wt 62.3+ est. 64.2 ?
also left 6-C-4 femur see below probably same bird
also a smaller femur 6-C-4 see below
of a different individual

6-C-6 carpometacarpus length 80.1
also a toe & proximal ends manus carpo.

6-C-7 left femur int. length 62.6, est. length 63.9
dist. br. 14.5 post. br, prox br. 13.4

6-C-4 left femur wt length 54.5, est length 55.9+
dist breadth post br 12.4, prox br. 11.4

~~GB32~~ 89 - rt. carpometacarpus length 68.1+

2 humeri
1 coracoid
3 femora
2 carpometacarpi
6

8 this page
+28 other side
36
27
63
+ yellow sheet left under with addn of 28

Compare
Loc 3499 coracoid (Humerus 9560*) Complete length coracoid possibly 46.5+ (45.3?) to internal tip sternal facet
10984 or coracoid 12.2 above, Scap fragment sh. 5.8

Loc 6688 Coracoid br 14.2, sh 6.3 ?
17498

Loc 1625 coracoid length 50.4
21042

Sulidae add Oct 28 to pencil list (3)

~~1622/120022 dist humerus bx 16.7~~ vent bottom of pencil list

checked 1625 ~~cracroco~~ rt - Vagabundus? pencil list called 1963

21042

1625/51661 frag prox shaft Sulidae

checked 1625/41441 dist left ulna v aff?

~~1625/17606 dist rt Sula~~ Sulidae pencil list

~~3366/59170 prox left coracoid~~ Sulidae in pencil list

3162 (122956) ant. part sternum

3162 (122958) prox left tarsometa

checked 3162/ prox left coracoid

(22997)

Coracoids 3162 (122968) Rich complete left coracoid v aff?

3162 (122974) dist frag rt coracoid

checked 3162 (122973) prox rt coracoid (very large)

checked 3162 (122972) prox rt coracoid

checked 3162/(22978) dist humerus rt

checked 3162/(22969) prox humerus left

3162/(22984) dist ulna Anas (Sulidae?

3162/(22977) rt prox femur

3162/(122975) left prox carpometa

4173/(117714) dist rt tibia Sulidae

checked 4174/(122997) dist rt humerus Sulidae

3162 (123357) left complete but poorly preserved carpometa. Sulid

3230 (119229) - dist ulna Sulid?

3162 (122986) - vent Sulid?

6688 (158897) - dist rt femur Sulid Nunook Oper

40
39 < 6p.3
79

4 + 15 = 20
1625
4

3162 - 14 + 2 = 16

cataloged
Kay 47
14
61

18
39
70
28
155

Sulidae cont'd

~~4956 6-C-8 prox humeri left~~ back of pectoral list

4956 (6-C-10) dist humeri left

~~4956 coracoid left complete 6-C-5~~ back of pectoral list

assn'd 4956 (6-C-23) prox rt humeri, rect (6-C-22) + cranial fos. (6-Z-21)

~~4956 Sq 6-C-7 left complete femur larger than~~ back of pectoral list

~~4956 Sq 6-C-4 left " "~~ back of pectoral list

~~in matrix 4956 Sq 6-C-3 rt almost complete femur (may be offset of 6-C-7~~ back of pectoral list

4956 (Sq-1-1H-7) dist end radius

~~4956 Sq 6-C-6 nearly complete left carpometa (large)~~ back of pectoral list

?1 dent? ~~4954 3-D-23~~ prox frag. carpometa OUT

4874 (37-E) coll'd 1981 by Larry Barna dist humerus rt
size = vagatinder

4874 (Sq 36-A-11) coll'd by Sam the Sled dist carpometa

~~3449/98601 assn'd rt coracoid prox humerus, prox ulna~~ dist humerus, prox ulna
Rose on vagatinders on pectoral list

family?} 4956 - dist ulna + prox ulna + frag of shaft assn.
Sp.?}

4956/(2-D-23) dist humerus rt (condyles 14.2, 8?.6, 12.0 otherwise)

~~4956(?) L B3 2855~~

4874 (Sq-39-F-1) dist end rt ulna large Rob R coche 1981

Sulidae sp. immature

27 bone sides
+ 20 from femurs
8
55

humerus	IIII
coracoid	I
femur	III
radius	I
carpo	III
~~tibiotarsus~~	

Measurements of Subadult Shacktoe Mtn Hills

Holotype R dist br ar pubis 18.3 (cast 18.5; cast L 15.0

R	Hemi [illegible]	122976	gr 20.5	condyles only	15.8 lvr 3162
R	Dist.	122991	gr 21.8	condyles only	16.3 lvr, 4174
L	Dist	4956/6-C-10	gr 21.0	" "	16.1 lvr 4956
L	Dist	4956/2-D [illegible]	gr 18.6	" "	14.6 lvr 4956
R	dist	1622 104100	gr 19.4	" "	15.3 lvr 1622 prox 21.5
R	dist	1625 5/1660	gr 20.7	" "	15.5 lvr 1625
R	dist	1625/74352	gr 18.5	" "	14.2 lvr, 1625
R	dist			" "	14.1 lvr 1625
L	dist	1625/13950	gr 17.3 unc	" "	lvr 1625 prox breadth 21.8
L	prox	1625/38801			lvr 1625 prox " " 21.4
R	dist	9860	gr 16.5	condyles	13.3, lvr 3499
R	dist	72817	gr (16.2)	"	13.4?, lvr 3162
R	dist	17491	gr dist 17.4	"	13.8 lvr. 6688 prox br. 22.8
R	dist+prox				length 165.1 mm
R	left prox	122964			Lvr 3162 prox br 21.5
L	prox	50618			lvr. 6655 prox 22.9
R	dist	Sq. 37-E	gr 15.2	condyles	14.8 lvr 4874

Baja Calif. and the Chandler dist humerus gr 16.0; condyles 12.3

R	9860/3499	br thru scar facet	(11.9), gr. br. 12.7	lvr 3162
L	122971	br thru scar facet	12.9, gr br. 13.0	
	cracked			
R	21042	length 51.6 in tip,	57.6 Vertically, (11.7) br. thru scar facet	
	3162	" 51.9 " "	59.3 " , 13.1 " " " gr br 14.0	
L	122968			
R	3162/122973	lvr 3162;	br thru scar facet, (14.9) gr. breadth 16.4	
	furculated			
R	122972	" 3162 " "	" " 12.4 " " 12.9	
R	17498/6688		14.1	14.8

Ulnae

L	16473/1625	breadth prox 13.6, depth	13.4
L	38800/1625	" " 11.1	11.4
L	16492/1625	" " 11.7	
L	17407/1625	" " 12.0?	
R	16470/1625	" " 12.0? depth 11.5?	
R	9860/3499	" " 11.9 " 12.0	dist br. gr 12.5, depth 9.8
L	uncat' Raschke 1981	dist gr. br. 14.1,	condyles only, depth 10.0 9.5, sh. 8.3/7.0

over for modern

Sula leucogaster leucogaster

#1349 = 86438

Humerus prox br. 20.3, dist br. 16.6, condylar 12.4
ulna prox br. 11.2, depth 11.0 dist gr. br. 10.1, condylar 7.6, depth 8.6
coracoid int length 49.6; vert. length 51.7, br. 10.2 (Humscap facet) gr. br. 11.7

#1352 (86439)

Humerus prox br. 23.9, dist br. 19.2, condylar 14.4
ulna prox br. 13.2 depth 13.5, dist gr. br. 11.4, condylar 8.4, depth 10.7
Coracoid int length 51.9, vertical 56.9, br. Humscap facet 12.9, gr. br. 14.6
(#251, 54.3) (54.5) (#251, 12.1) (#251 13.6)

prox br. humerus varies from 20.3 – 23.9
dist " " " " 16.6 – 19.2
prox br ulnae " " 11.2 – 13.2
dist br ulnae " " 10.1 – 11.4
coracoid length " " 47.6 – 54.3
" br " " 10.2 – 12.9

Mono bassanus br. dist humerus 24.0, condyles 19.5 ap.? prox 31.3 (2)

Suleo Tyke dist-vagabundus ~~18.0 91 b~~ 18.7 91. br.

4956 / 2-D-33 dist humerus br - (18.5) (condyles only 13.7
" " " 15.8
4956 (6-C-10) " humerus (20.7) " "
check 4956 (4-C-8) prox humerus br. 29.1
X 3499 / (9860) dist humerus (16.5) (coracoid 46.8 vagabundus
3162 / (72817) dist humerus (16.2) (condyles 13.2

~~mono bassanus coracoid lusk 61.5, prox ht 27 (292) br. 16.8~~
coracoid 6688 (17498) - ht prox end 22.2, br below furcula facet 14.2
Subl coracoid 3142 / (122971) - ht prox end 19.5, br below furcula facet 12.0
Coracoid 4956 (6-C-5) lusk ht 57.7 ht prox 25.1
coracoid 16225 / (21042) lusk ht 52.2 " " 29.5
coracoid 3142, (22973), br. 15, ht 24 to tip or 23 under facet
coracoid 3162 (122947) br. 12.6

Humerus
1622 (10404) br dist. (19.5) (condyles 16.2); prox br. 21.5
1622 (18002) br dist condyles (17.2)
✓ 1622 / (16465) br prox end 22.5
✓ 1625 / (38801) br prox end 21.3+ vagabundus
X 1625 / (51660) br dist end (20.65) condyles 15.7?
1625 / (4332) br dist end (18.5) condyles 14.2 (prox is there too but can't be measd)
Rec. 1625 / (13980) br dist end (17.+) condyles 13.1
4174 / (122497) br dist end (21.8), condyles 15.9
✓ 6688 / (17494) prox breadth 22.6, dist br. (17.6) condyles 13.6 (lusk ht 163.5
X 6684 / (50618) prox br. 23.3, ~~to~~ vagabundus
✓ 3162 / (122969) prox br 21.5
✓ 3162 / (122970) dist br. (20.6) condyles 15.5
3162 / (122985) dist br. (18.1) condyles 14.1
(4874 / uncatal.) br dist end complete (mended) radius Sulidae ?,

Sulid Coracoid 3162 (122965) Complete - lusk ht 52.7, ht prox 21.5, br. below furcula facet 13.1

For size records on Sulidae
Shearwater Hill
Humeri & Coracoids

Range Humeri
prox 29.1 - 21.3
dist 20.7 - 16.2
Tyke dist 18.7, 11 larger 111

smaller 111 equal 111

27 bones
This page

Important comparison
Solid humeri Hercir
bottom of page

S. leucogastra Check Humerus 6 – c – 8 proj br. = 28.5 H Jan 8, 1985

Nov. 17, 1983

Size range of Sharkstooth Hill Sulids vs. Sula leucogastra brewsteri

Humerus

28.5 H 6 – C-8 br 4956 (Steamer eroded, maybe wider)

max prox. breadth 22.9 (H 50618 br 6688) or 23.3 [28.5 H 6 – C-8 br 4956 (Steamer eroded, maybe wider)]
min. prox breadth 21.4 (H 9840 / br 3499)
                   21.8 (H 122997 br 4174) [Holotype 18.3 as published cast 18.5]
max dist breadth   16.2 (H 72817 br 3162)
min " "   14.5 (uncatalogued 4956 – 6 – D
mean " " (of 12)   18.85
(not counting br 4956)

Modern S. leucogastra ~~23.3~~ H 23.9 max difference of 3.6 mm
                       20.3 min
                       4 4 2
                       23.8
                       3) 4 8 0
                       22.6 mean of 3 moderns 1 below mean
                                               2 above

difference in dist br 5.6 fossils
of fossils 21.8
            16.2
            5.6 mm

H below 18.5, 5' holotype 18.5 on cast
H above 18.5, 6

Br. condyles only in holotype 15.0.

fossil max 16.3 } difference 3.0
" min. 13.3 } number specimens above mean 5
" mean 14.8 " " below " 6

169.79
187.39

Coracoid br. thru scap facet (7 bones)

max 14.9 } 3.2 difference
min 11.7 }
mean 12.8 of 7 bones H below mean 4
                      # above " 3

coracoid of modern S leucogastr 12.9
                                10.2
                                2.7

Ulna prox br. 13.4 max
               11.1 min mean 12.0
               2.5

gr. dist br. 14.1
              12.5
              1.6

leucogastr 11.4
            10.1
            1.3

Shahtoolk Hill Loc 1625 Sahtaa

all have hole at op brachial emmin

17607	Ulna	prox	12.0+	ref. to M. vagabundus on label	Br. Sh.	G1/5.4
16470	"	"	12.0+	" " " "	—	6.2/7.8
14473	"	"	13.6 Depth 13.4	" " " "	—	5.4/6.4
38800	"	"	11.2 depth 11.1	" " " "	—	5.4/6.4

Loc 45-46 H 120433 Ulna prox 14.1 depth marrow cut = .5 mm greater than largest Shahtoolk Hill (see above) 2.1 mm greater than smallest above 8.2/7.6 Br. Sh.

OSO Dam Exit #5 length @ waist 182 m

Humeri Shahtoolk Hill

Humeri

S. Hill 1625	38801	br	prox	21.5	length def to head	35.0	Br. Sh. 9.8 below deltoid
				?		40.3	10.1
GOOD → 74332			dist	18.45 (= type)			
Type of Morus vagabundus			dist br.	18.3 @ narrow 18.5 cast			
1625	51640	dist		" " 20.5	br above brachial 11.7 mm		
6688	#17498	length		163.4	dist br. 17.4		

Coracoid

Loc 6688	#17498 (reended)	gl. br.	14.3	Br sh.	17.0	Shahtoolk Hill
Loc 45-46	#120428		12.35		6.1	OSO Dam assoc with humerus ▽ tentatively assigned ☐ S. wide dist

Loc. 47'46 Sulidae 7a

S willetti ?

Tarsometatarsus 120432

length 44.4 (tarsus in UCLA 2839 = 43.8 or 44.7

See tablet upper pages Oct 1980 for small Sulids

Sulid meas. of sternum

Sula stocktoni from cast of type

	manubrium (sternum?) to apex of keel	sternum to apex of keel	manubrium to xiphiid	Ratios a:b	Rt. D2 P1 length	Rt. D2 P2 length	length humerus	ulna	sternum to manubrium tip	prox to xiphiid (ext.) sternum	Rt. P1 D2 length	left P1 D2 br.	Carpus	prox length + coracoid	length free of coracoid	gr. length coracoid ?
S. stocktoni	43	118	152	36.4	49	36	~~253~~ 261	173.6 171.5	41-42?	114.6	46.5 48	13.5	98	25	10.5	86
M. bassanus USNM 15173, 2657	46	98		46.9												
S. bassana 1352	32	65		49.2												
" " 1349	28	51-52		53.8												
dactylatra 1356	38	84		45.2												
piscator 2553	32	73		43.8												
Santolus 1339	32	63		50.7												
San Lenardo	24	57		45.6												

Rt. humerus: to tip of head 10.5 mm. above int. tub.

but head above int. tub. ~~103~~ 16.6

cast must have shrunken slightly from the originals since each element is slightly shorter than as given by Miller

UCLA specimens measured at LACM May 1, 1975

	Skull length subnasal oc. to hip bone	gr. Depth skull to mand.	gr. Depth brain	Length tarso-metatarsus	Br. sl. tarso-metatarsus	Prox. br. tarso-metatarsus	Length tibio-tarsus	Length humerus	Length femur	Length carpo-metacarpus	Length outer toe	Length middle toe	Length inner toe	Length hind toe	Length ulna	prox. br. humerus	dist. br. humerus	coracoid	length pelvis	br. pelvis across anti. trochanters
# 2839 labelled S. willetti Lompoc.	135.6	40.5	20.1	43 R 44	7.0	10.1	98.4 79.3	160+? 13 173.4?	56.2?	63.7?	74.8	79.1	48.3 — unjoint (+10?)	17.0?						
# 2543 S. willetti Lomita	—	—	—	41.4+12 ?	6.55	?	73.7? 70.3?	145.1?	47.7?	73.2	47.6 ?	—	—	14.8 — unjoint	123.6?					
Aquarius type 2542 type Lompoc S. willetti	type 129	39.6	25.5	43 R 44.5	5.5	8.0	69.0	155.5	52.5	69.3	type 75	type 74	type 53	type 14	145.9					31.5
# 2840 Lompoc	147 inc.	54.8	36.8?	55.6	5.7?	9.6?	106.5	128.3+ 20 248?	65.0			89.1	65.1	21.7 mutilated	164?	27.9	22.0			
# 2835 Lompoc	Skull only 139.8	41.5	22.9	—																
# 16 labelled M. ossula media Lompoc diverse of type	—			type 64	cast 8.5	cast 14.1	cast 89	type 180	—	type 81					type 140	cast 24.5	cast 21.5	cast 68?		
Sula personnata						cast 13.7		type 248	type 69						cast 180 2nd	type 28.	cast 25+	type 6.2	cast 11.0	cast 38.6
# 2838 Aquarius willetti Lompoc	skull 1	—	—	54.6	?	13.0	92.3	—	63 3rd 69.2	—	101.8	98.0	73.2	with unjoint 27.8	—	—	—	—	101.5	43.7
Plate 9 Gyrfalcon est.				est 62.8		est 24.8?	est 91.6	est 237	est 77.2	est 91.2					est 203					

Shenkman Hall Subject

Coracoid
+z 104z
Loc 1625

57.2 gp length, 52.2 axial

See loc 1557
for facet

humerus
U17496
Loc. 6688

163.4 dist bn 17.4 prox 22.8
11 22.9
+ 5061 x Loc 6688

coracoid
17499 Loc 6688

bit from scap fact 21.6

Compare Dromedus
don't have same elements
1945 + 6902 - 6906!

See contents
list with
Shenkman Hall
Study
1982

Sulids – Sonora UCLA

52.3 / 4 / 209.2 ; 58.7 / 4 / 234.8

* = good meas.

Glass removed for these meas.

	Humerus left	Radius (radius shaft)	forward of shaft Length ulna to olecranon	Ulna to art. c,	Length carpo-meta	Radius length with forward ulna	on S. willetti type specimen	Humerus br prox humerus	Humerus br dist humerus	Humerus br shaft near prox	measd through slabs ½" tibia	measd through slabs ½" tarso	DIP1 mann	DPP2
Sula willetti recent type	* 6 in = 152 mm	147.2 ; 146.4 / 142.7	*	139 *	69.8 *	145.1 *					64.6	42.5		
Sulcopicana recent type ?	→ 2 specimens one of which is recent type ← humerus complete →							28.4	22	13.0				
	8 3/4" 222 mm							28.5	20.8					
S. stolonis cast type	9 3/4 247 mm		171.5 mm 6 3/4											
Sula willetti from Lomita	145.6		152 ?		72.2						tibia 72	tarso 38	ratio 52.7	
Miocula medius	7 9/16 192 mm		113.1 mm		76.4 ?						82.6 ?	63.0	35.8 ?	33.0
											br dist tibia 12.8	coracoid length 73.7		
Sulcopicana cast type	25.7 br prox end humerus 29.4 (palmar side)		ulna side				70.9 length femur length deltoid 47.6 br. dist fem 23+?				← br cora. at scap facet 18?		60.0	lat coracoid 25.7 broken

	Leg bones tarso	tibia	femur
measd 3. Lomita	42.7	69.3	45.4

13.8

155.3

Large Swifts from Calif. Late Miocene

	Skull length	Humerus length	ulna length	carpometa. length	coracoid length	femur length	tibio length	tarso. length
M. lompocana (1) type – fig. vert. Fig. 44 Quinby Miller 1922	245	—	—	42 axial	69	—	—	
cast of norm. 14 mm	280	—	—	60 → axial (66 qr.)	71	—	—	
M. lompocana (2) UC 115855 = Miller Pl. 9 meas. by H	—	229 br dist 20.4	202.4	96.6	66.5 axial 73.6 qr.	74–76.4	106.5 depth dist. 12.5 (mit) br 13.7	169.7 + 60–63.2 ?
M. lompocana UCLA #2840 (3) marked lompocana by Fisher measured meas. by H 144.3 mm.		humer 202+ br prox 28.7 br dist 22.7	182+?			65.7	104.6 + 54.5 (159.1)	
M. lompocana UCLA #2838 (4) Miller Pl. M meas. corrected meas. by H lompocanus meas. 193.8 mm. in comparison with Sula stocktoni		230	201	93		70.8	94.5 + 53.6 (1 58.1)	
		possibly referable to Pl. 9 specimen						
Undet. Emarg. slab LACM 1752 Sherman # 5001		218+	—	—	—	init. ext. 66–69.7 length	109.1	66.2
Laguna Niguel LACM recorded as lompocanus H pub. figs.							LACM # 37634 94.7 + 95.7	LACM # 37697 # 522.7 depth dist. 12.4 br. 13.7 (latter compared to Miocalles & Hesperhirundo by H)
Lesser Works Loc. A945 recorded as lompocanus ? # 17570.								br. dist 13.3 # 17570 depth dist 12,5 both 13.0 mm. nearest
Miocalles media type multip figs 19,35 in stratonic paper	281	140	85					64
Micrula media type figs given by Miller 1925	180	140	81.					
Micrula media type mixed meas by H on latex pull from type (T Cartmael cavern)	"C" 190?	139	"C" 79,8?	69,4 axial)		C 90.1 br dist 12.2 depth ?	152.8 + 62.7 dist 15.0 prox 13.2	
Sulidae sp ? Laguna Niguel # 57834						br dist 12.0 depth 11.5		
MODERN M. bassanus	(286–228) 228. dist br. 24.0	196	94	axial 60.9		100.5	59.3	
Morus magnus H figs.	dist br 29,2		116.1					
Sula stocktoni type cast figs 111		ulna 170.5						
S. stocktoni type figs per Miller ex Sierra Buenos	264	178.0	102					
	247–252 est.							

	a Tarsus	b tibia	c femur	ab	cb	ac	humerus	ulna	carpus
new fossil	45.3	80.5	57.3	56%	71%	79	—		
willetti	41	71.0	52.0	57	73	79	156	147	70
kamtschatica	—	—	69.0	—	—	—			
Recent media	64	—	—	—	—	—			
							150	170	69.3
pahli									
Modern									
brevirostris ♂	49.9	75.0	49	61+	65+	94			
" ♀	51.4	83.5	55	61	66-	92.5			
dactylatra	61.8	96.7	62.9	64	65	98.5			
nebouxii	51	83.6	53.4	61	63.5	95.5			
websteri	39.3	71.9	51.5	— ?	68.5 54.6	71.6	76.0		

Recent Sulids

Study of Mike Bell's specimen

from Delgado Rivr W. Sepulveda

Feb. 5, 1962

Specimen assigned to S. willetti

KNOLL

Sulid from Mike Bell - Sepulveda locality
3 leg bones considerably fractured.

a length tarsus 45.3 mm. (to center trochlea
b breadth " 8.4 (middle)
c br prox. end " 11.9
d ext length tibia 81.4 (to top of cnemial crest
e " " " 80.2 (to center ext. cnemial crest
f " " " 80.8 (ext cond. to ant. surf of prox. end
g length femur 57.3 (ext. length (or length pos. on Aves specimen
h depth prox end 9.9

Recent species →

	S. brevirostris ♂ 13498	♀	♂	♀	nebouxii ♂ 25.3	♀	Sula leucogaster 1339	Morus bassanus 18173
a	45.9	51.4	54.8	61.8	50.9		39.3	57.3
b	7.0	8.0	10.1		7.0		8.1	8.6
c	11.9	14.2	15.5		11.8		12.2	13.9
d	76.2	84.7	97.5		85.7		73.7	104.2
e	75.0	83.7	96.7		83.6		71.9	102.9
f	73.8	82.5	95.0		82.9		71.4	100.0
g	49.1	55.3	62.9		53.4	56.9	51.5	69.6
h	9.0	11.9	12.5		10.1	11.4	10.7	13.3
length humerus	147.3	166.0?	195.7		168.2	184.9	169.3	223.6
length ulna	159.7	177.8	208.7		182.2	201.2	189.4	191.6
least length ulna	153.8	169.7	198.0		175.6	191.2	171.1	200.4
ext length DIS carpus	70.6	77.5	89.3		77.5		73.7	89.7
int length carpus	65.0	76.1	86.2		75.0		71.6	87.4
length radius	154.5	176.1?	203.0		177.1	194.4	183.2	185.3
int length coracoid	46.8	52.5	60.7		50.4	55.0	51.5	60.8
ext length sternum	51.3	57.2	66.9		55.7	61.4	56.9	71.0

105
89 4

1126
886
2012

86 4
81 8
168 2

102.6
88 6
91 2

919
93 6
1855

56
121

68 4
116.5

111 6
111 4
94
97 5
200 4 94 1

84.7
98.5
183 2

86.5
82 8
169 3

82 6
93
115
74.4

90.4
92 8
115.4
55.7
171 1

102.6
93.1

122.7
86.4
208 7

113.1
85 9

Comparisons are difficult to make. A list of these species, & the represented material, follows.

The family Sulidae is very well represented in the American fossil record. Unfortunately, however, the recroded species are represented by different skeletal elements, or the preservation is different, so that

Sula stocktoni -- wing bones, and sternum and partial coracoid imprinted in diatomaceous shale. Miocene, Lomita, Calif

Sula willetti -- nearly complete skeleton imprinted in diatomaceous shale. Miocene, Lompoc, California

Sula guanoBrodkorb -- nearly complete left coracoid, two fragmentary ulnae and distal end of tibiotarsus. Miocene, Pliocene Bone Valley formation, Brewster, Florida.

Sula phosphata Brodkorb -- Coracoid Pliocene, Bone Valley formation, Brewster, Florida.

Sula avita Wetmore -- Distal end of humerus and nearly complete carpometacarpus. Upper Miocene, Calvert formation, near Plumpoint, Maryland. (Disassociated material)

Sula humeralis Miller -- Distal end of humerus, nearly complete femur, and proximal half of ulna (Disassociated material assigned to the same species). Pliocene, San Diego, California.

Miosula media Miller -- wing bones, tarsometatarsus and distal end of tibiotarsus imprinted in diatomaceous shale. Miocene, Lompoc, California.

Miosula recentior Howard -- Tibiotarsus. Pliocene, San Diego, Calif.

Morus loxostylus (Cope) -- Coracoids, distal end of humerus (disassociated specimens, assigned to same species). Miocene, Maryland and New Jersey.

Morus vagabundus Wetmore -- Distal end of humerus and ulna lacking proximal end. Disassociated material assigned to the same species on the basis of size). Miocene, Sharktooth Hill, California.

Morus lompocana Miller -- Wing bones, coracoid, scapula, femur and pelvis (TYPE) imprinted in diatomaceous shale; and wing and leg bones imprinted on another slab of diatomaceous shale. Miocene, Lompoc, California.

Morus peninsularis Brodkorb -- Coracoids and cervical vertebra (Dissociated material assigned to same species). Pliocene, Bone Valley formation, Brewster, Florida.

Morus reyana Howard -- Nearly complete coracoid. Pleistocene, Del Rey, California.

Three extinct sulids are recorded from the Oligocene and Miocene of France, as follows:

Sula pygmaea Milne-Edwards. Humerus. Middle Miocene France and, doubtfully, a sternum

Sula arvernensis Milne-Edwards -- Pelvis. Upper Oligocene. France

Sula ronzoni (Gervais). Pelvis. Lower Oligocene France

Sula universitatis Brodkorb carpometacarpus, Low. Miocene Florida
Sula pohli Howard inc. skeleton Up miocene Calif.

p. 6 separate subgenera of OK
Sula (Microsula) aïta
Wetmore 1938, p. 25

Table II Brudenell's Table 4, p. 13
1955 (coracoids)

p7 Mors lox. descr. by Cope
1871 p. 236 (coracoid end)

p7 Wetmore, 1926 p ~~461~~ 466
M. lox. is Morus

p7 Wetmore 1930 pp 90-91
p. 14 M. vag. is Morus

p9. length of humerus of S. willetti
Miller 1925 p 169
fig 4 pl. 8

p11. Miller 1935, 35-38
class. of S. stantoni
length max. extent
p. 12 Brudenell 1955 p 38 Table I
p. 14 length of S. stantoni in table 26

Wetmore 1930 p. 91

(a) S. wilsoni is dulo

(b) dorso vag. sigh dif.

264

4) 175 (43.75

3

89 131,15

175

43

218) 175

1

175) 220

264) 175

150

175) 264

175

890

875

45

4.3.58

Measurements (in millimeters) of Sula pohli, cSula willetti, and Recent specimens of Sula leucogaster brewsteri

	S. pohli Right	S. pohli Left	S. leucogaster brewsteri L.A.M. no. 1349	S. leucogaster brewsteri L.A.M. no. 1352	S. willetti Type	S. sula websteri	Comparative Specimens
Ulna, length	170.0	148.5	159.0	177.0	147.0		123.6?
Humerus							
Length	150.5	145.0	147.2	166.0	156.0		146.4?
Breadth prox. end	22.1	22.1	20.0	24.0	----		23.5
Breadth dist. end	17.3	17.9	15.5	18.2	---		—
Carpometacarpus							
Length	69.3	69.3	70.5	77.3	70.0		69.4 67.2
Coracoid							
Length (axial border)	....	55.0	47.2	52.3	45.0		—
Breadth head	11.4	....	10.4	12.8			
Breadth at scapular facet	13.7	....	11.7	14.0			
Height from head to procoracoid	....	19.1?	16.9	20.1	16.7		
Sternum *							
Length from xiphius to tip of carina		94.3	95.0	114.0	.....	110.0	115.2?
Distance from manubrium to tip of carina		35.3	43.4	46.5	.....	46.8	51.4
Depth of carina through manubrium		28.7	26.0	31.1	.....	33.5	
Distance from sternocoracoidal process to xiphius		57.0	51.0	62.3	.....	63.3	66?

*The same measurements of sternum in Sula sula websteri are as follows: total length, 110.0 mm.; manubrium to carina 45.7 mm.; depth carina 33.5 mm.; Sternocoracoidal process to xiphius 63.3 mm.

Sula

	length	Gr. prox	dist
Femur dext	66.2	13.1	17
tibia	109.1		
femur sin	69.7	12.9	—
ext	66.9?		
humerus	218+	31+?	220

Coracoid
12.5 lat gleno

Radius 6.1

ulna 16.3 depth

S. fusca

humerus 151
17 dist
22.5 prox

ulna 14.7 depth prox

Sacrolitic tarsus 41, tibia 71

Microsula media 11 64, humerus 180

Humerus GB, 15.3 Granudy willetti complete
22.3 (Eucoin slab 19.8 small? 30+?

Tarsus fx-lr.

12.2
(Bell)
13.1
Eucoin

160
57.7
217.7+

Measurements (in millimeters) of Coracoids of

Fossil Sulids

	S. pohli	S. willetti	S.guano	S.phosphata	M.loxostylus[a]	M. peninsularis
Length on axial border	55.0	45.0	50.0	[illegible]	48x8-50.5	54.0-55.6
Height of head above procoracoid	19.1	16.7	21.0	21.0	19.8	25.0-25.1
Breadth head	11.4	....	13.4	12.7-13.5	[illegible]	14.2
Breadth at scapular facet	13.7	....	14.7	13.8-14.5	[illegible]	17.-17.7
Length articular facet	10.5	....	10.3	2.5-2.7		8.6-10.8
Ratio breadth head to length on axial border[1]	20.7	....	26.8	[illegible]	[illegible]	26.3
Ratio breadth at scapular facet to length ftnt[2]	24.9	....	29.4	[illegible]	.2817	32
Ratio height above procoracoid to length[3]	34.7	37.1	42	[illegible]	39.2	45

1 average for this Same ratio in Recent sulids (Howard, 1936, p. 213) Morus, 26.7, pSulan 22.9
2 Same ratio in Recent sulids " " " " 30.8 " 26.1
3 Same ratio in Recent sulids " " " " 42.9 " 38.6

a Estimated measurements [illegible] proportions are based on Bradbook (1955, pp. 11-13, pl. 1-2) description, & best illustration.

a It is not clear from the original description whether the measurement of length can be considered complete for the element or whether it merely expresses the length available on the specimen.

Length on axial border

S. pohli S. willetti M.loxostylus S.guano S.phosphata

Measurements of Coracoid in Fossil Sulids

(in millimeters)

Kept 4.3.58

Ratio of humerus : coracoid

willetti 156) 450 (29.0.90
312
1380
1394

Whitsett 150.5) 5500 (36
4513
9850
9030
0420

M. Bassanus 228) 6070 (26.6
456
1510
1368
1420

S. l. brewsteri 166) 5230 (31.5
498
250
166
840
830

Ratio ulna : coracoid

147) 450 (30.6
441
900

172) 5560 (32
516
400

196) 6070 (30.9
588
1900

177) 5230 (29.5
354
1690
1593
970
885
850

s. brewsteri coracoid 169.5) 5170 (30.5
5085
8500
8475

Ratio ulna to carpus

willetti 147) 700 (47.6
388
1120
1029
910

Whitsett 170) 6930 (40.7
680
700
680
20
41
1658) 6820
6632
2480

M. Bassanus 196) 940 (47.9
784
1560
1372
1880
1764

Sl. brewsteri 177) 773 (43.6
708
650
531
1190
1062
145

humerus : carpus

156) 700 (44.8
624
760

150.5) 6930 (46.0
6020
9100
9038
7000

228) 9400 (41.2
912
280
228
520

166) 7731 (46.5
664
1090
996
940

Formida humerus : carpus

1464) 6940 (47.0
5856
10840
10248

= 44 ulna

157.7) 6940 (44.8
6188
7520
6188
13320

Whitnett Sula

57)260 (45% ratio dist from manub. to proces to dist from proc to xiphius
228
320

Sternum lt. at manubrium 30.5
length from " to tip of xiphius 94.7
" " sternocost. junc to " 51.3
lt carina from sternocost. junc. to tip of carina 57.6
" " calipers flat on ventral keel of carin. + dorsal lip of manubrium 31.0
" " to vent lip of manubrium 26
length carina ventrally — 60
length carina along shield — 47.5

95)4270 (44% Gannets
3828
4420
3828
49
613)30.50 webster
2452
5980
5517
4630

Carina is relatively short & deep as in Sula websteri

144
18.5
1625

41
1625)6680
6500
1800

46.3
950)4400
3800
6000
5700
3000

41
943)3900
3772
1250

43
114)493
456
370

45
110)465
440
650

59
668)3940
3340
6000

668)3940

Keep 4.3.25

Ratio humerus & Tarsus

willistii 156 | 410 (26.2) — 312, 980, 936, 440

Lemita 146.4 | 4270 (29.1) — 2928, 13420, 13176, 2440

M. bassanus 228 | 5930 (25.9) — 456, 1370, 1140, 2300, 2052

S. Brewsteri 166 | 5060 (30.4) — 498, 800, 664, 136

Humerus & carpus

S. Hortulani 264 | 10200 (38.6) — 792, 2280, 2112, 1680, 1584

Humerus & Ulna

willistii 147 | 15200 (103.4) — 147, 500, 441, 590, 588

Whitneyi 150 | 15050 (100.3) — 1360, 1450

Lemita 155.3 | 17640 (94.2) — 13977, 4630, 4212, 4180

154.7 | 14500 (93.9) — 13893, 6070, 4641

Ulna & carpus

175 | 10200 (58.2) — 875, 1450, 1400, 500, 25

228 | 1960 (8.6) — 1824, 1360, 1348

M. bassanus 196 | 22800 (116.4) — 196, 320, 196, 1260, 1176, 840, 93.8

S. brewsteri 177 | 16600 (93.8) — 1593, 670, 531

148 | 14650 (98.9) — 1332, 1330, 13

Lemita 146.4 | 6440 (44.2) — 628, 660, 584, 320, 314

S. dactylatus 208 | 19500 (93) — 1872, 780

Swainsoni 189 | 16950 (89.6) — 1512, 1830, 1701, 1790

Sneboux 183 | 16750 (91.7) — 1647, 280, 183, 970

Rattus Taurus Co tilicia

wellett 57.8
71) 410
pub 355
mus 550
497
1630

69.3) 4270 = 61.6
4158
1120
693
4270

59.0
M bassaus 1005) 5930
5025
9050

61.4
S brewsteri 824) 5060
4944
1160
824
3360
3296

59.1
693) 4100 measor
3465 remise
6350
6237
1130

Measurements of Sula willetti
and Sula leucogaster brewsteri

	Type	Paratype of Type	Lomita 2 males	♂ 1349 Small	♀ 1352 large
Length of humerus	156	~~154.2~~	146.4	147.2	166
Length of ulna	147	146	138 ? 124.1 ? ? 155.3	159	177
Length of Carpometacarpus	70	69	~~67.2~~	~~70.5~~	77.5
Length of Tibiotarsus	71	69.2	~~68.5~~ 69.3	73.5	81.5
Length of Femur	52	52	~~Rt 45.4~~	49.1	55.6
Length of Tarso-metatarsus	41	47	~~Rt. 42.7 ? Left 38.5 ?~~	46.1	50.8
Length of 1st toe	14	—	22.1 33%	~~24.8~~ 34% mid.	~~27.6~~ .34 of mid
Length of 2nd toe	53	—	44.2	49.5	~~57.0~~
Length of middle toe	74	—	65.5 ?	71.	~~79.1~~
Length of outer toe	75.5	—	66.2	~~71~~	~~81.0~~
Length of sternum ~~xx~~ overall	—	—	108 metatarsal I 10 mm.	94.5	110.6
Distance from sterno-coracoidal process, to tip of carina	—	—	60	53.5	63
Breadth shield of sternum	—	—	40	37	42

Meas of fossil sulids

	M. laevistylus	M vagabund.	S. avita	S humali
Humerus				
Br. dist.	21.1	18.3	15,2	19.8
	S. willetti	M. lor.	S. guano	S phaphata	M peruvianus	M. regamo
Coracoid	?					
55.6 Length on ax. border	.45	48.2-51.3	.50	—	54-55.6	56.0
Ht head 19.1 abiui procora.	16.7	15,4?	21	21	25-25,1	24,7
11.4 Br. head	11.4	?	13,4	12,7-13,5	14,2	15.5
13.7 Br. at scap facet	13.7	—	14,7	13,8-14,5	17-17,7	17,1
27.7 Ratio br head to leyth.	25.3		26,8		26.3	27,4
Ratio br at scap facet, to leyth	30.4		29,4		32	30.2
34.3 Ratio distance fum procoracoid to head, to leyth	40.0 ~~33.9~~ ?		42		45	43,6

41.1
45) 16.50
1620
500
41

mm. Measurements of S. longipsana

from Miller Mts.

	Type PR 9	PR 7B	Type (measured)		San Fernando Specimen
Humerus	59.0	—	111.8	(245)	227
Length				28.0	30.2 prox br.
Br. prox	8.4				22.2 dist br.
Ulna					
Length (Ossification)	51.8?	—	—	—	
Tarsus					
Length	16.3 = 65% of 21.4		32.8	67.5	66.1 (13.4 prox br.) 10.6 br. sh prox.
Tibia					
length (mor duct)	28.5	38.0	—	115.3	109.6
Femur					
ext length max	19.4	29.5	—	—	
int. : min	18.7		31.7	(69.0)	69.6?
Coracoid					
Length med (Clavepectoral int.	16.9	—	27.3	(62.0)	67.8?
Pelvis					
length sac	42.3?		49.9	(103)	
Br acetab	20.1		18.5	(40.0)	
Tarsus to humerus	27.6%				30.6%
Tibia to humerus	48.3%				50.7%
Femur ext to humerus	31.7%		26.9%		
coracoid to humerus	28.4%		23%		
Tarsus + tibia to humerus	57.2%				60.5%

145
12
227 Paleocene Stockton
264

Pelecanoides urinatrix, Palaeospheniscus skoddensis
Cal.
humerus 24.4, carpo. 10.2
Morus bassanus
Humerus 245
coracoid 62
femur 69
Morus capensis
Humerus 160
Tarsus 64
Morus serrator
Coracoid 54-55 (br at scap facet 17-17.7)
Morus loxostylis
Br. dist end humerus 21.1
coracoid length 50.5 br at scap facet 14.5
Morus vagabundus
Br. dist end humerus 18.2
Microsula arnoldi
Br. dist end humerus 15.2 carpo. 65 (dist px 15)
Sula guano
Coracoid 50 br at scap facet 14.7
Sula dactylatra
Coracoid br at scap facet 13.8 - 14.5
Sula leucogaster
Br. dist end humerus 19.8
Sula willetti
Humerus 156,
Coracoid 45,
Sula fiberi
Humerus 145-150.5
Carpus 69
Coracoid 55 br at scap facet 13.7

Sulidae - Differences between Morus & Sula
Recent

4.4.66

(dates in ( ) are Wetmore)

Humerus of Morus:

Distally
- External condyle slender, elongated, excavated on inner side at its ginial appearance of being flexed at this point (1926)
- Articular surface for pronator muscles ["s" s/c] plane and considerably elongated (1926) – adds "narrow" (1930)
- Olecranal depression lacking pronounced overhang on inner side where there are a few small foramina (1930) [ext? by observation #]
- Brachial impression shallower, especially less excavated along external border than in Sula (## observation)

proximal
- Shaft below head on anconal side broad & nearly flat (no angular ridge) (## observation)
- Externally very gradual slope from pectoral attachment to shaft (best observed anconally). (## observation)
- Palmar side, bicipital furrow practically nil – on same level as bicipital surface.

Humerus of Sula

- External condyle broader, shorter, rounder & lacking pronounced inward flexure at upper end (1926)
- Prominence for insertion of pronator short & irregular (1926) 1930 he adds "much rounded".
- Olecranal depression with evident overhang on inner side with large, easily evident foramina at this point (1930)
- Brachial impression deeply excavated, ridge marks external border (## observation)

Ulna of Morus & Sula compared

- External cotyla more elongate in Morus (1938 "Morus sp. from calcaut fm.") Wetmore says, however, that this may not always hold; Sula (#) cranium heavier, less pointed, in Morus than in Sula (#)
- Brachial impression narrower & more depressed in Morus than in Sula [the reason of the char. of the impression on the distal end of the humerus] (##)
- muscle attachments below ext. cotyla extend diagonally medial for greater distance in Morus; in Sula it is a larger papilla; in Morus more of a ridge.

Morus vagabundus description
Wetmore 1930 humerus (distal end)

bone and shaft flattened w/ the broadish pronator fossa brachialis inferior, bordered ext'ly by low, rounded margin and internally by abrupt flat that merges w/ the pronator tubercle"

Pronator "tubercle" flattened, plane, narrowed, elongate ant. and very slightly elevated

Ulnar (int.) condyle elevated + protruded ant'ly, irreg'y globular at inner side where it projects as a ball, sloping rapidly externally (?) as an elongate ridge

Large olecranal depression behind int. condyle

Radial (ext) condyle elongate, compressed, elevated, curved in ward at upper end where outer side tip are under cut.

Sula humeralis dist. humerus
Miller + Bowman 1958

Impression of brachialis anticus defined distally by transverse ridge (as in S. leucogaster he says)

Distal to this ridge brachial depression triangular in outline

(1) Base transversely under overhang of int. condyle

(2) External side defined by ridge extending obliquely in from ext. condyle

(3) Int. side defined by entepicondylar prominence [is this the same as pronator attach?]

Area more depressed than in Morus

Int. border of brachialis depression forms pronounced ridge broadening distally into a fairly heavy mass of bone [is this also Hofmann's trace?]

Entepicondylar area less pronounced than in living sulids

Viewed distally, ulnar condyle larger in comparison to radial condyle

Dorsal in most Sula

Medial ridge of tricipital groove less developed, ext groove thus appears to lie more towards "capital" line than to lateral border

Outer ridge of tricipital groove well developed

Curvature of shaft as in living forms, straighter than Miocula

aPr. dist. 19.8
Smith. Brsh. 8.0
ratio
Sa 40%
Smith 7.7
pronator attach.

Procyonidae Lexistylus referred humerus from Miocene, Calvert Co., Md.
Wetmore 1926

Distal end

Shaft flattened on anterior (?) palmar? face, impressed by broad area for brachialis inferior

Brachial impression deepened on inner side, shallow externally; bordered externally by low, narrow, raised margin bordered int'ly by abrupt plate that slopes up to merge with the pronator tubercle

Pronator tubercle long & narrow (8.5 mm) with anterior elevated so that viewed from external side it presents an oblique flattened isosceles triangle with upper end as apex, which slopes away in faintly concave line to right & left

Ulna "tubercle" (= condyle?) relatively small, strongly protruded anteriorly (?) (palmarly?) excavated under (int.) upper side so that it has a slight overhang above impression for brachialis inferior

Olecranal depression large & broad

Radial condyle compressed, elevated, curved inward at (ext.) upper end where external side is undercut; upper margin of process stands out boldly above that & its walls rising at sharp angle from the base

Sulcus anconei lateralis a deeply impressed U shaped groove cutting posterior facet of ext. condyle

Sulcus anconei medius broad & shallow, well marked inward & above olecranal depression disappearing beyond

Rt. dist. end 21.1 – br. shaft at level brach. imp. 13.5

ext. condyle 7.0 → length ext. radial condyle 10.2

" " 7.2 → " " " 9.5

Rt. dist. end 18.3

"Anteroposterior" "Vertical length" same dimensions in vagabundus Wetmore 1930

over description M. vagabundus

Nipsula
Tula, avita Wetmore description (Wetmore 1938

Humerus (distal end) type
Br. dist end 15.2 ; br. shaft (at top of brachial impression?)
Bone gone above this

Ectepicondylar process slight, extending out in gradual curve
Inner margin of shaft flush-edged
Radial (ext.) trochlea rounded, but seems broader than in Nova (Brodkorb so
shaft of flip is not evident)
Ulnar (int.) trochlea rounded, long., globular, projecting
distinctly distally below level of ext. trochlea
Bracial depression flat, slightly impressed,
Tubercle for pronator brevis elongate, triangular, rising
in low point.
Olecranal fossa shallow
Short attach. of ant. articular. (called by Wetmore "insertion
for pronator muscle)

Carpometacarpus
Prox'ly large, heavy, mostly above central axis of bone
referred sp., when viewed from side (this means about 2/3 to 3/4 above axis)
Approx 64 mm long; depth proximad from M1, approx 14mm (+)
(measured on drawing)

Process of M1 rises more abruptly than in S. piscata
and process larger + pneumatic foramina smaller

Note the subgenus Nicrula is set up to "signalize" the lesser
pneumaticity of the bones of this bird

Thermodax
primitive pelecanoid
sub-fossil Florida

FOSSIL sulids

Pleistocene
large Morus bassanus (Linnaeus) . Rec. species recorded from Norway as fossil
large Morus reyanus Howard. Coracoid, Del Rey, Calif.

Middle Pliocene
large Miosula recentior Howard. Tibiotarsus, possibly ulna and frag. humerus San Diego, Calif.
Sula humeralis Miller and Bowman. Humerus (distal) and nearly complete femur. San Diego, Calif. Ulna from Miosula recentior transferred to this species.
large Morus ? unpublished Gigantic coracoid. San Diego.

Pliocene? Bone Valley, Florida beds lie between Miocene beds and Pleistocene
Morus Morus peninsularis Brodkorb. Nearly complete coracoid of medium size.
Sula guano Brodkorb. Nearly complete coracoid of medium size, and two fragmentary ulnae and distal tibiotarsus.
Sula phosphata Brodkorb. Several coracoids of medium size

Miocene
Miosula media Miller. Lompoc, Calif. partial skeleton in matrix: wing bones and tarsometatarsus, part tibiotarsus. Rather large
Morus lompocana (Miller). Lompoc, Calif. part skeleton in matrix 3 specimens Rather large
Morus vagabundus Wetmore, Shark-tooth Hill, Bakersfield. Distal end of humerus and fragment of ulna. Smallish
Morus loxostyla (Cope). Maryland and New Jersey. Left coracoid (type) Distal humerus and shaft of humerus referred. Medium size, or smallish? [illegible] end is given)
Paleosula Sula stocktoni Miller. Lomita, Calif. partial skeleton in matrix. Very long humeri, short ulnae. Legs missing. Coracoid shows, incomplete measurement indicates it is larger than that of Morus bassanus and procoracoidal process longer and head to procoracoidal notch greater. Size large.
~~May be Morus~~. New genus Paleosula
small Sula pygmaeae Milne-Edwards. France. Very small. Humerus 128 mm. long (22 mm wider than S. stocktoni)
small Sula avita Wetmore. Maryland. Distal end of humerus. Very small. 15.2 62
Left [redacted] carpometacarpus. Shaft of humerus, also.

Oligocene
Too large Sula arvernensis Milne-Edwards. France. Size of M. bassanus. (but narrower) Pelvis
" " Sula ronzoni (Gervais). France. Size of M. bassanus. Pelvis

Morus, sp.

A proximal end of tarsometatarsus (LACM 16463) is of larger size than LACM 16464 assigned to Morus vagabundus. Like the latter, it resembles Recent specimens of Morus in the short posterior extent of the middle calcaneal ridge, but has a raised intercotylar area. It differs from LACM 16464 in greater length of the posterior surface of the internal calcaneal ridge, and greater posterior extent of the hypotarsus, even exceeding the tarsometatarsus of M. bassanus in this dimension (see table).

Of the several species of large sulids that have been described from the Tertiary of North America (Morus lompocanus, Paleosula stocktoni and Miosula media from the Miocene, and Miosula recentior and Morus peninsularis from the Pliocene), the tarsometatarsus is available only in Miosula media. Measurements made of a reverse cast of the type specimen of the latter species show the tarsometatarsus to be of approximately the same proximal breadth as in the Sharktooth Hill fossil, but more slender of shaft, less depressed on the anterior surface, and having a longer, less rounded tubercle for the tibialis anticus muscle.

In the Los Angeles County Museum of Natural History collections there is a partial skeleton of an unidentified sulid on a large slab of Miocene shale from Encino (San Fernando Valley), Los Angeles County, California (LACM 5001). The elements that can be compared with those of the type of Morus lompocanus (a reverse case of which is at hand) appear to agree favorably in size and proportions, although exact dimensions cannot be taken on either specimen. The Encino specimen also includes a tarsometatarsus split longitudinally so as to obliterate any external details except overall length and transverse breadth. LACM 16463 from Sharktooth Hill, when laid on the Encino tarsometatarsus, coincides in breadth of proximal end and shaft. By this rather devious series of comparisons (type of M. lompocanus

-- to LACM 5001 from Encino -- to LACM 16463 from Sharktooth Hill), it is sugge suggested that the Sharktooth Hill specimen may represent Morus lompocanus. At least, in view of this possibility, it would be out of order to describe another species at this time.

Table 4 (Sharktooth Hill)

Measurements of Tarsometatarsi of Morus

(Measurements in millimeters, proportions in per cent)

	fossil Morus, sp. LACM 16463	fossil M. vagabundus LACM 16464	Recent M. bassanus LACM 18173 (Miller p29 S. lentus)
Breadth of proximal end	13.7	12.7	14.6 (13.8)
Depth of proximal end from anterior edge of internal cotyla to posterior tip of hypotarsus	14.2	12.6	13.6
Length of posterior surface of internal calcaneal ridge	7.3	6.1	8.6
Ratio of depth of proximal end to breadth of proximal end	103.1	99.1	93.3
Ratio of length of posterior surface of internal calcaneal ridge to breadth of proximal end	53.3	48.1	58.9

The large ulna recorded by Miller (1961:401) as Morus sp. may belong to the same species as tarsometatarsus 16463

Length Range in Sula brewsteri
5 3/4" – 6 5/8"
149.2 mm – 168.2 mm
min is 88% of max

LACM Specimen # 2764 Published 1958 as Sula pohli

Comparison of Whitsett Sulid with other fossil sulids → Sula pohli

Range in (br. dist.) Sula brewsteri Modern
15.4 – 18.3 mm, ± 15.4 is 83% of 18.3

Humerus – can be compared in size only

Those with 2 ✓✓ are very close
Those in red ✓ below could be within range
[that is within 83% – The range notes in S. brewsteri
(15.1 is 83% smaller, 21.9 is 83% larger)
132 is 88% " 170 is 88% "

length 150.5 ap.
br dist. 18.2

✓	Morus loxostylus	br. dist	21.1
✓✓	Morus vagabundus	br. dist	18.3
✓	Sula anita	" "	15.2
✓	Sula humeralis	" "	19.8
OUT	Sula pygmaea	—	length 128
OUT	Morus longpeana	—	length 245
OUT	Sula stocktoni	—	" 264
✓✓	Sula wileti	—	" 156
OUT	Miosula media	—	" 180
OUT	Highland Park	—	" 142 +

Humerus to ulna length ratio

NONE agree

Humerus 150.5 } humerus ratio 87% of ulna
Ulna 172.– }

OUT	Sula stocktoni	264 (hum)	175 (ulna)	= 150% hum to ulna
OUT	Sula wileti	156	147	= 106%
OUT	Miosula media	180	140	= 128%
OUT	Morus longpeana	245	201	= 121%

150.5 (hum) 172 (ulna) = 87%

2764 described as Sula pohli

Range in S. brewsteri
length — 47.7 — 54.7
br head — 10.3 — 12.7
gr br. — 11.8 — 14.2
ht dorsal — 17.1 — 20.6

Ratio: 1 21.3 - 24.1
" 2 24.7 - 27.0
" 3 35.8 - 38.0
" 4 85.4 - 89.5

Comparison of Sula & other fossil sulids continued

✓ = possible within 4-8 mm length range (range of Sula brewsteri)
✓✓ = definitely within range

Coracoid

Length 51.4 (axial border - approx.) possibly more

Br. at greatest protrusion — 13.7

Br. head — 11.4

Ht dorsal part (approx.) — 17.6?

		Sula Sbrewsteri (21.3-24.1)	Morus
① Ratio Br. head to length	22.1 %	22.9	26.7
② Ratio Gr. Br to length	26.6 %	(24.7-27.0) 26.1	30.8
③ Ratio ht dorsal part to length	34.2 %	(35.8-38) 38.6 —	42.9
④ Ratio least br to gr. br.	83.2 %	(85.4-89.5)	←
⑤ Ratio gr. br to ht. dorsal part	79.9 %	(68.9-69.0)	74.3

OUT Morus peninsularis

Ratio ① 26.3 %
Ratio ② 32 %
Ratio ③ 45 %
Ratio ④ 80-83% ✓✓
Ratio ⑤ 68-70

length 54-55.6 ✓
br head 14.2
gr. br. 17-17.7
Ht dorsal pt. 25, 25.1

OUT Morus serrator

Ratio ① 27.4
Ratio ② 30.2
Ratio ③ 43.6
Ratio ④ 90.6
Ratio ⑤ 69.3

length 56.4
br. head 15.5
gr br. 17.1
Ht dorsal pt 24.7

OUT Sula granti
on ratio's

Ratio ① 26.8
Ratio ② 29.4 ✓?
Ratio ③ 42.0
Ratio ④ 91.1
Ratio ⑤ 70.0

✓✓ length 50
✓ br head 13.4
✓ gr. br. 14.7
✓ Ht dorsal pt 21

— Why isn't this Morus?

Coracoid continued

OUT Sula phosphata
Ratio ④ 92 – 93%
Ratio ⑤ 68.6 – 69.3(?)

length ——
br head 12.7 – 13.1
gr. br 13.8 – 14.5
Ht dorsal pt 21

Morus loxostyla
Ratio ② 26.9
Ratio ③ 32.3
Ratio ⑤ 82.7%

length 48.2 – 51.3
br head ?
gr br. 13?
Ht dorsal 15.7?

OUT Morus bassanus
length 62

Sula willsi
length 45'
Ht dorsal pt? 19.3 (?) measurement
Ratio ③ 42.9.0.?

OUT San Diego specimen
Ratio ① 26.1
Ratio ② 30.4
Ratio ③ 46.3
Ratio ④ 85.7
Ratio ⑤ 75.6

length 67.0
br head 17.5
gr br. 20.4
ht dorsal 27.0

Ruled at 25 — possibly repr'd by Whitsett Specimen

Morus longifolia — Numerous is 243 instead of 150+

Comparison of Whitsett sulid with other fossil sulids, continued

Carpometacarpus — length 69.3 mm.

Sula stocktoni 102 mm.

✓ Sula willetti 70

✓? Sula anita 65

Sula pygmaea 81 =? Plus minor + Morusia media

Ratio humerus, ulna, carpus

With carpus as 1 (H) 2.17 — (U) 2.48 — C 1.00
carpus = humerus + ulna 46% 40%

Sula stocktoni H 2.59 — U 1.71 — C 1.00
38.6% 58%

Sula willetti H 2.22 ✓ — 2.10 — 1.00
44 47

Mio Sula media H 2.22 ✓ — 1.72 — 1.00
45.0 58.1

Morus lompocana 2.63 — 2.16 — 1.00
38.0% 46%

Species to which Whitsett cannot be assigned cont'd.

Morus longicana

Too large

Humerus longer than ulna

Ulna shorter in proportion to carpo, also
(46%; Whitsett 40%)

Sula guano

Length OK

Head broader (rel. to length 4.7% greater)
" " br. scap facet 8% greater)

Ht dorsal pt greater (rel to length 8% greater)

Morus reyana

Larger

Head 5% broader rel to length

Scap facet br. 4% broader rel to length

Dors pt 7% higher rel to length

Head rel to br scap facet 7% broader

Sula pygmaea

Too small

Sula arwenensis } Pelvis - both size equals
Sula ianzoni } M. bassanus - Plus too long
for Whitsett

Species of sulids ~~to~~ which Whitsett cannot be assigned.

Sula stocktoni

Too large

Humerus longer than ulna

Carpometacarpus 58% of ulna (Whitsett 40%)

Morus peninsularis

Possibly within size range, even no larger for length

Head 1 4% broader rel to length

Br at scap. facet rel. to length 4% broader

Ht dorsal part rel to length 11% higher

Proportions are ---> Prog Morus

Whereas Whitsett is Sula.

Sula phosphata

Br. across scap. facet is close but

Br of head is greater. Ratio of

Br of head to br scap facet

92-93% whereas Whitsett is 83.2%

Miosula media

Too large

Humerus longer than ulna

Carpometacarpus 57.8% of ulna (Whitsett 40%)

Miosula recentior

No bones for actually comparison,

but size is larger than any

other forms so must be too

large.

Species of sulids to which Whitsett can be questionably assigned: ——

OUT Sula willetti

Length of humerus OK (6 mm. greater)
Length of ulna too short actually & relatively (to 60th carp. & hum.)
Coracoid appears to have longer dorsal part
(perhaps 42% of length? – Whitsett 34.2%)

OUT Sula avita

Dr Whitsett
Process of Metacarpal I projects straight forward & crests of proximal trochleae rising higher above this process than in S. avita; Whitsett more like modern

Humerus distal end is just within size range as indicated by modern Sula brewsteri 15.2 (Whitsett 18.2; modern Sula brewsteri range 15.4–18.3)

Coracoid also within range 65.0 (Whitsett 69.3 Modern Sula l. brewsteri 47.7–54.7 = 7 mm. range)

Sula humeralis

Humerus breadth within range 19.8 (only 1.6 mm. larger; mod. S. l. brewsteri ranges 3 mm.)

Morus loxostylus

Br. humerus within range 21.1 = 2.9 mm range (mod = 3 mm)

Length coracoid OK
Relative Breadth of coracoid OK & also
lat. of dorsal part (as measd on illus.)
is within 2%

Morus vagabundus

Br. dist. humerus same
BUT described as typically Morus whereas Whitsett has coracoid & wing proportions of Sula.

Whitsett fossil distinguished as follows:

from Morus vagabundus — Size apparently similar but vagabundus ≈ dumitus as typical, Morus where Whitsett is Sula on basis of coracoid proportions, (ulna to humerus long slant "

(Morus has long humerus short ulna)

from M. longirostra — Wh is Sula ↑ is smaller

from Sula storkstoni — Wh is smaller ↑ ulna is longer than humerus (humerus longer in storkstoni)

from S. guano — Coracoid mc. ulnae ↑ tibia

ratio br. ar scap facet to up. procoracoid lit above 65–70% Whitsett 80%

— overall size of coracoid similar, Proportions of coracoid breadth, ↑ height of upper part differ. Guano relatively wider ~~and~~ but shorter (see table) top part mar like Morus ~~Especially~~ slender from procoracoid to head.

? from S. plesipleata — as for S. guano ± less ht. from procoracoid to tip of head; & narrower both at head ↑ scapular facet

from S. humeralis — more slender shaft

from Morus peninsularis — smaller but in range?
but Whitsett is Sula not Morus

43
12
86
43
516

$$
\begin{array}{r}
68.2 \\
165\overline{)11240} \\
\underline{9870} \\
13700 \\
\underline{13160} \\
5400
\end{array}
$$

$$
\begin{array}{r}
68.1 \\
165.5\overline{)11270} \\
\underline{9930} \\
13400 \\
\underline{13240} \\
1600
\end{array}
$$

$$
\begin{array}{r}
65.6 \\
163\overline{)1070} \\
\underline{978} \\
920 \\
\underline{815} \\
1050
\end{array}
$$

$$
\begin{array}{r}
64.2 \\
165\overline{)1060} \\
\underline{990} \\
700 \\
\underline{660} \\
400
\end{array}
$$

$$
\begin{array}{r}
65.8 \\
159\overline{)1047.50} \\
\underline{954} \\
910 \\
\underline{795} \\
1150
\end{array}
$$

Similar to Sula as contrasted with Morus as follows: ① Ulna markedly longer than humerus; ② coracoid relatively narrow, short from procoracoid to head & between pectoral & scapular contacts; ③ humerus angular on ulnar surface near proximal end & pneumatic fossa

Compared with living members of the genus, sternum closest to S. webster in shortness & deep short carina; ratio of ulna to humerus is closest to webster (114%, web. 111%) & straight distal

	humerus	ulna		length of pec	breadth
dactylatra	195	208	106%		
websteri	169.5	189	111%	57.7 20	14.3 13
nebouxi	167.5	183	109.7		
brewsteri	166.2	177	107	52.0 20	14:1 12.7

Humerus:

Distinguished from living Sula & outer contour contours of humerus; as follows: ① bicipital crest more markedly indented & below median crest; pneumatic fossa narrower & more angular; in palmer view as seen on specimen #, ligamental furrow broader & more deeply incised; distal condyles equal distal development giving distal contour a straight, squarish appearance ×

USE 4,358 Cl.

Morus has humerus longer than ulna

Sula has ulna longer than humerus

Should Sula willetti reallyy be in Morus (has long humerus) Sula pohli has humerus

Sulidae

	Length Humerus	Length ulna	Length carpometacarpus	1st phal. major	2nd phal major	Coracoid (axial border)	Tarsus	br. dist humerus	br. prox humerus	sternum: sterno-coracoidal process to carina base	sternum: sterno-coracoidal process to xiphius	tibio-tarsal articulation to xiphius	Depth carina	Ratio br. head to length	Ratio br. to articular facet fibula	Ratio length dorsal portion to ventral length			Ratio humerus to ulna
long hind toe (Morus?)																			
S. willetti	156	147	70	P1O2 35.5 +5.1	P2O2 23.2	45	41									38			
M. large longipennis	230 later (245)	201	93			62			28		115								110
Morus media	180	140	81	35	37	—	64												128
S. aff. ?			65.3 mean					15.2											
Morus/Sula								21.1							26+?	32?			
Morus? S. storkstoni large	264	175	102	P1O1 40	P2O2 32					43	118	152							150
M. capensis								24.8?											
M. serratus								22.5											
Morus? S. cassana	228	196	94		P1O2 48?	60.7	Tibiotarsus 100.5 59.3	23.7 24.3		46	98	134							116
S. reboux'i	169	185	77		36						73	97							
S. bruesteri	166	177	79		36		Tibiotarsus 82.4 50.6				68	92							
M. vagabundus								vagabundus 18.3											
Sula pohli	146.5 left	148 left												% br. scap/coracoid 80	% 90				
S. whitsetti	150.5 left	170 left	69.3	P1O1 23.4 18.7	P1O2 33.0 P2O2 19.7	Br. cora 19.0? at scap facet	radius in 6½ 164.7 mm	18.2	22.1	57.6	51.3	94.7				38.6	sterotyla		87%
Sula "pisator" sage	155															37.7	S. willetti		
Sula humeralis	—	—	—	—	—	—	—	19.8						28.2	26.6	34.2	whitsetti	upper H's for sp. deyrolli Morus in size class	
M. nebouxii														27.4	30.2	43.6	M. nebouxii		
Morus														26.7	30.8	42.9	Morus		
Sula pohli	150	170												22.9	26.1	38.6	Sula		
M. personatus														26.3	32	45	M. personatus		
S. granti														26.8	29.4	42	S. granti		
S. piscatrix?														61.1	30.4	40.5	San Diego		

	humer	ulna	humer to condyles dist.	ratio hum. : ulna	ratio hum + gr. length ulna
S. leuc. brevistriatus 1349	147.2	159 / 152.5	15.5	~~96.70~~	92.5
250	160.5	173.5 / 165.5	18.6	97	92.5
251	163.5	177.5	17.8	94	92.1
1352	166.0	177.0 / 169	18.2	98	93.7
S. neboux! 1783	185.5	200.5 / 192	19.0	97	92.5
253	167.5	183.5 / 175	18.2	95.70	91.4

Size span 15.5 – 18.6 for S. l. brevistriatus = 83% (smallest to largest)
may also 2020 change from hum

164
147
19

change
leuc
brevis

18.5
14.7
3.8 orange neboux!

186
155
3.1

190
182
8.

150.1
125.0
22.1

5.8
4.1
58

232
22) 29.7 × (10
2.8
1.7

22:41 = 5.8 : x

		humerus lateral facet to last or. at top glenoid to last	
Sula sula	1339	69.3 % 58.3	13.4 – 11.3
S. leuc.	251	69.6 57.9	16.6 – 14.7
"	1349	68.1 59.5	
S neboux!	253	64.0 61.6	19.7 – 19.5
Morus bassanus	18173	73.7 65.9	
Eltanin forsteri		64.2 – 62.4	
S dactylatra	1356	69.3 60.3	

Pliocene - Sulid

Miosula recentior et al

	a ext length tibia to top fibular ridge	b Prx dist end	Ratio b:a
Type M. recent	96.7	14	14.4%
M. bassana 1873	87.0	13	14.9%
M. bassana 267	88.0	13	14.7%

Loc 1752 [illegible] LACM 5001

Cuerno Solid (slab) specimen no. 5001

a Tarsometatarsus length	66.2	175.3	UCMP 115835 (multiple)	60-63	for comparison M. lomfocaue type
	109.1			106.3	
c Tibiotarsus					
c Femur	~~ext~~. 69.7			69 (71.1?)	
	~~int~~ ?. 66.9			245 (280?)	Palaeoscula stocktoni 264
	218 +			229	
d Humerus					
Ratio a to b	60.5%			55.6%	
Ratio a to c	94.8%			82.6%	
Ratio c to b	64.2%			67.4%	
Ratio a+b to d	80.4%?. o.k.m			73.7%	

red means for
Pearson made 3,13,58
very carefully

Sulids

19.2
16.5
8.5
44.2

19
29
10.5
58.5

		Length Premaxilla	Length Maxilla	Length Nasal Aperture	Length Tibia	Length Femur	Length Carpometacarpus	Ratio humerus to tibia	Length Humerus 1	2	3	4	x aut edge sternum coracoid process to caudal	a Length	b Width	c aut edge manubrium to carina	d Depth Cranium	Depth carina Ratio d/x	short carina cx	Depth carina cx
#2542 S. willetti neuneq type		154.2	144	41.0	69.3	52.0?	69.0	106	14	53	74	75.5								
S. willetti Lomita #2543		146.4 ?	124.1 (155.3)	38-39+	68.9 ant. 81.5 sup. 69.3 to artic.	45? 45.4	69.4	118	22.3	44.2	60?	66.7								
Wintzett																				
Kepplei 349 1352													46.3	44.0	95.0	51.0	23.2 39.3	26	5.7 112	5.3	24.4
S. l brewsteri 1339													43.0	44.3	114.0	62.3	27.5 46.5	31.1	4.3 113	5.5	24.1
Sula s websteri													45	46.5	110.0	63.3	25.0 41.4	33.5	7.1 134	5.5	22.7
M. bassana													41	66.8	162.5	99.8	27.5	39.4	59		
Wintzett													41	39.0	94.3	57.0	18.6 32.8	28.7	7.3 154	4.7	19.7
Sula loxostyla	(inc) length mm dict. L	Coracoid in incl. by at base of scapular articulation																		
inches	2.02	.57																		
mm.	51.6?	14.5 ap.																		

Measure sternum from process to aut. tip manubrium

Last sent written it is humerus or ulna that differs in Nyctes & Sula

Miller, UCLA Publ. Biol. Sci. vol. 1 # 5

p. 77 says;

In the Recent pelicans, cormorants, & boobies the humerus is definitely shorter than the ulna, in the Tropic birds the 2 segments are about equal in length, & in the gannets & Anhinga the humerus is longer than the ulna.

This last relation of parts is the one to be found in the fossils of the Miocene deposit of Lompoc (California) where 3 species occur, the bird under discussion [S. stocktoni] fits into the same picture.

[Therefore S. willetti & S. stocktoni are both Morus!?]

Brodkorb apparently overlooked this for willetti,

Brodkorb He says that S. willetti, S. pygmaeus & Sula are smaller than any living species

Wetmore 1926 p. 468 says that gannet
Today there are;

Moris bassana - North atlantic
" serrata
" capensis so. Africa

fossil M. loxostyla is smaller than any of these

slightly smaller than bassana

Wetmore 1938 says M. vagabundus is decidedly smaller than M. serrator.

It is also probable that the ulna is longer than the humerus. Both Bell 1933 & Bradhorn 1955 p. 8 have

1 suggested that these proportions are peculiar to the boobies (Sula) as contrasted to the gannets (Morus). However, ~~Sula wilsoni~~ ~~the humerus proportions~~ with Wetmore (1930 p. 91) finds clearly to fall into the genus Sula on the basis of other characters, has ~~the proportions~~ a short ulna.

Sonnini

1456) 7200	50	hum
7280		tib
72) 380	52	tib
360		tars
200		
1456) 3800	26	hum
2912		tars
8880		
8736		

Wilsoni

152) 66.60	43
608	
5180	
666) 42.50	64
3996	
2540	
156) 710	45
624	
860	
71) 410	56
355	
550	

Wilsoni

156) 410	26	hum
312		tars
980		
180) 640	35.5	hum
540		tars
1000		
900		
100		
498) 1650	33	
1494		
1560		

Mexicana

$$
\begin{array}{r}
95 \\
152 \overline{)\,145.6} \\
1368 \\
\hline
780 \\
760
\end{array}
$$

$$
\begin{array}{r}
98 \\
149 \overline{)\,147.3} \\
1341 \\
\hline
1320
\end{array}
$$

S. 58.113

PHOTOGRAPH BY SECTION OF PHOTOGRAPHY
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Fig. 1

[fig. 2 is the reverse & is quite similar]

Sula pohli Howard TYPE

S.58.115

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Fig. 3

Reprod
Palaeosula stocktoni (Miller)
Genus by Howard (from specimen of Hunter Alhambra "El Serano")

Published records of meas. of subids

	Length	Humerus: Gt. diam.	Humerus: Br. shaft & Deltoid depress.	Humerus: Ht. ulnar condyle	Humerus: Ht. radial condyle	Coracoid: Length on axial border	Coracoid: Head to process coracoid	Coracoid: Br. head	Coracoid: Br. at scar facet	Scapula: Least depth shaft	Scapula: Length sternal facet ext.	Scapula: Length sternal facet int.	Scapula: Br. near mid.	Distal gaunter of Br.	Ulna: Br. proximal	Ulna: Length	Tibiotarsus: Length	Femur: Length	Femur: Br. shaft min.	Femur: Br. prox.	Pelvis: Length synsac.	Pelvis: Br. thru acetab.	Carpus: Length	Tarsus: Length
M. loxostyla	1	21.1	13.5	7.0	10.2	48.2–51.3	from illus 15.4?		from illus 13.?	5.0–5.8	14.2	—												
M. vagabunda	1	18.3		7.2	9.5																			
M. pompeiana	245					62							7.4	20.2	1	201					103	40	93	
M. peninsularis						54–55.6	25–25.1	14.2	17–17.7															
M. regana						56.6	24.7	15.5	17.1															
also 2 digits rstemum S. stocktoni	264															175							102	
also 3 meta, 2 digits S. willetti	156					45?										147	71	52			70	32	70	41
sp. miss. tarsus & ulna S. guano						50	21	13.4	14.7															
S. plicopleatus						?	21	12.7–13.5	13.8–14.5														65.0	
S. avita	1		15.2																					1
S. humeralis				meas on illus 7.5%	10.2%									1	14.7		1	58.2						
S. pygmaea	128																							
Miosula media	120															140	114.0	5.5	13.2				81.0	64.0
Miosula recentior																								
Wintersett	145.16	18.2				55.0 diff 51.1–53.?	19.1 17.6?	11.4	13.7							149 170							69.3	
Highland Pk	224 2 152.5		15.0																					
San Diego						67.0	27.0	17.5	20.4															
S. arenemeris																					109.5	31		
Penzoni																					115?	32		

Lost from illus
Miller Ed

	loc 7136 X 42657	loc 19455 17554	Sula 1349	Shaketown 16463	Shaketown 16464	Sula 2553	Sula 1356	Mono 18173	Domeda 13890	32 6915
Ist prox. corglar	12.25	12.1	10.7	13.8	12.7	11.3		14.6	16.3	12.5
ext. depth prox through calcaneum	8.4	8.1	—	8.3	9.8 muted	7.15		6.8	12.1	8.2
Ist hypotarsus at base	7.9	7.1	6.4	7.8	7.0	8.0		8.2	9.2	7.5
Ist at dist. sup. of muscle scar	8.1	8.7	8.2	10.2 —		8.8		10.8	8.9	8.2
distance from intercotylar tubercle to dist. edge of muscle scar	11.3	13.2	9.8	11.2	10.4	10.4		12.3	16.4	10.8
Distance from prox. edge ext. hypotarsus to foramen (post.)	5.0	4.7	4.4	6.7	5.2			4.9	6.9	4.1
Ext. →	4.8	5.7		6.5	5.9	6.1		6.4	7.7	?

Both fossils have more prominent intercotylar tubercle than Mono (Sula more prom. than Mono) and more lat. fossa. Domeda much higher

Foramen in 42657 (ext. post.) is slight above dist. edge ext. hypotarsal ridge (Domeda) More as in Mono (Sula the ridge is above the foramen) but in Mono the ridge itself is shorter + broader.

Ext foramen above dist-ext hypotarsal ridge (thought broken) and not depressed but about flush with shaft In this flush position, resembles Di modern but is not higher. Also resembles Sula 2553 which is less depressed ant-ly than other Sulas or Mono

Miocene Orange Co.

Sulidae

Smaller Solids from Calif. Museums

	skull length	humerus length	ulna length	carpometa length	radius length	femur length	tibio length	tarso length
S. willetti type mean per Miller 1925	129	156	147	70	H mear. 45.0 axial	52	71	41
UCLA 2535 cited by Miller as not needed H mean another specimen 2534	142.2 like 142?	suggests comparison rather than willetti						
S. willetti UCLA 2539 Miller Pl 8 but not necessarily him H mean.	133.7						77.8	43? br. mig 12.2
Reverse 2542 S. willetti meas by H		152.5 (155.5?)	(145.9?) 146.4	(69.3?) 69.5		(52.5?) 52	(69?) 69.5	43-45 marg. 8.0?
S. willetti Yuma recrd by H UCLA 2531		(153.4?) 149.	(153?) 150-52	68.8			(73.3?)	(40.8) 42
S. pallidi type H 1958		left 145 rt 150.5 dist br 17.5	left 148.5-170 dist	69.3 rt + left	55.0 axial crown		Nalgas	
S. willetti legs from Delgado Davis loan						57.5	80.5	45.3
"Microsoma" leg from Lot 1945		#17556 dist br 15.3		17555 mid dist unmeasurable				17554 prox br, 12.1 x 2.2 dr 8.7
Nomen vagabundus		dist br, 14.9 or 15.2?	given by Wetmore					

3.25 x 5
2 for .5 m 16.25